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SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LIX

JULY, 1934

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NUMBER 1

THE PICTURE OF VERY EARLY CARCINOMA OF THE UTERINE CERVIX

GEORGE VAN S SMITH, M.D. F.A.C.S. AND FRANK A. PEMBERTON M.D., F.A.C.S.
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FROM a study of the so-called "pre-cancerous" and early malignant lesions of the cervix, Pemberton and Smith included that in a given specimen the presence or absence of cancer could be determined with definitely and that the finding of "precancerous" characteristics did not necessarily indicate that cancer would develop later. On the contrary, the evidence pointed more to the view that early carcinoma may develop in apparently normal epithelium and spread superficially before invading and that the "precancerous" areas as often as not were stages in a healing process e.g. hyperkeratosis following infection or mechanical trauma. Others have emphasized the inaccuracy of the term "precancerous" and recently Schiller has again pointed out its ambiguity since it can be interpreted as meaning either that cancer may be the outcome or that the disease surely will follow. Further, he has demonstrated what he is led to believe are the characteristics of very early malignant disease of the cervix. In 1921 Cullen reported and profusely illustrated an early cervical cancer similar to those described by Schiller.

The object of this communication is to describe and depict 16 cases in which we independently have diagnosed early cancer of

the cervix on the basis of our own experience. These cases, we have found, resemble those of Cullen and Schiller. That others may not concur with us in our diagnoses we are well aware, since generally the pathologists to whom we have submitted sections for confirmation have dissented. The cases are briefly summarized.

CASE 1 (Fig. 1—Path. 6123.) In February 1916 this patient, Mrs. E.B., then 25 years old, underwent a reconstructive operation for lacerations and prolapse. She had had 2 children, the last in 1911. A right sided trachelorrhaphy was performed along with vaginal plastic operations and suspension. In March, 1920 4 years and 1 month later she was seen because of 8 months flowing and found to have advanced carcinoma of the cervix. Biopsy showed squamous carcinoma. Radium was applied. Death occurred 2 months later. The illustration is taken from the section of the trachelorrhaphy specimen which was diagnosed chronic cervicitis. A rediagnosis of early cancer was made. This case has already been reported (3).

CASE 2 (Fig. 2—Path. 9951.) At the time of operation (dilatation and curettage, trachelorrhaphy, anterior colporrhaphy, perineorrhaphy and supravaginal hysterectomy for chronic pelvic inflammation) in December 1921 this patient, Mrs. M.R., was 38 years old and had had a normal pregnancy 17 years previously. Four years and 9 months later radium was applied to an advanced squamous cancer of the cervix. She was alive with a recurrence 1 year and 3 months after irradiation. The photomicrograph was made from the section of trachelorrhaphy tissue. The diagnosis of chronic cervicitis

was changed to early cancer. This case is being reported by Dr. R. L. Pearse in a series of supra-vaginal hysterectomies (2).

CASE 3 (Figs 3 and 4—Path 13835) Mrs. S. S. aged 51 years. The last of 4 pregnancies occurred 13 years before admission. She was seen in May 1926, because of profuse leucorrhoea without bleeding, of 9 months duration. Examination and curettage under anesthesia resulted in a diagnosis of senile vaginitis. The patient returned in 2 months, unrelieved. On this occasion a specimen was taken from the cervix and radium given. The patient is well, over 7 years later. The pictures were made of the biopsy section. This case would have been considered too advanced for inclusion in this series were it not that two well known Boston pathologists did not appraise the lesion malignant.

CASE 4 (Figs 5, 6, 7, and 8—Path 14721) Mrs. B. O. aged 27 years. The last of 6 pregnancies had resulted in abortion 1 year before admission. Complaint flowing of 14 days duration. On April 5, 1927 dilatation, curettage, biopsy of the cervix, and trachelorrhaphy were performed. Two weeks later radium was applied. The patient was well over 6 years afterward. The illustrations were taken from sections of the trachelorrhaphy specimen. A general pathologist diagnosed the lesion chronic cervicitis.

CASE 5 (Figs 9, 10 and 11—Path 15106) Mrs. M. D. 41 years old. She had had 5 pregnancies, the last ending with an instrumental delivery 4 years before. On September 26, 1927 she was admitted because of dysmenorrhoea and pressure in the vagina. On dilatation and curettage, excision of urethral cyst, trachelorrhaphy for deep tear into

right parametrium, perineorrhaphy. A month later she was treated with radium and was well after 6 years. The photomicrographs were made from the trachelorrhaphy specimen which was diagnosed carcinoma *in situ*. This case has already been reported (3).

CASE 6 (Figs 12 and 13—Path 15457) Mrs. J. M., aged 37 years. Pregnancies 2 the last, ending with a premature labor at 7 months, 4 years before admission. Complaints profuse leucorrhoea, 5 years lower abdominal soreness and backache worse with menstruation, 6 months bloody discharge 2 months. Operation, April 12, 1927 dilatation and curettage, biopsy and cauterization of the cervix, supravaginal hysterectomy for chronic pelvic inflammation, appendectomy. Pathological report proliferating endometrium, fibromyoma, follicular salpingitis, chronic ovaritis, chronic appendicitis, chronic cervicitis. Because of recurrent staining, the patient was examined under an anesthetic on January 3, 1928. There was no cervical erosion and the os appeared normal. Three soft, red, bleeding ulcers without raised edges, all less than 1 centimeter in diameter and all less than 1 centimeter from the external os, were excised and showed the characteristics depicted in the photomicrographs. The patient was well when examined 5 years and 10 months after treatment with radium. Careful re-examination of the specimens removed at the first operation failed to reveal any evidence of beginning tumor although it would seem that there must have been incipient cancer at that time which was missed by the biopsy. This case has been reported (3).



Fig. 1.

Fig. 1. Case 3. Poorly defined basal layer fairly numerous mitoses heavy infiltration by round cells.



Fig. 2.

Fig. 2. Case 5. Distinct basal layer but cells are atypical and differentiated poorly. Mitoses are not numerous. Dense inflammatory reaction.



Fig 3

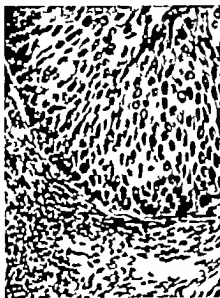


Fig 4



Fig 7



Fig 5



Fig 6



Fig 8

Fig 3. Case 3. No basal layer. Much infiltration by round cells.

Fig 4. Case 3. High power from Figure 3. Frequent mitoses. The cells are practically all of the spindle type.

Fig 5. Case 4. Poor basal layer. The cells vary in size, shape, and density of staining, but tend to differentiate. Moderate inflammation.

Fig 6. Case 4. High power photomicrograph made from same section as shown in Figure 5. Active atypical cells.

Fig 7. Case 4. More advanced stage of Figures 5 and 6.

Fig 8. Case 4. Beginning invasion.

CASE 7 (Fig 14—Path 16194) Mrs. A C, aged 30 years. One full term delivery 9½ years before admission. Catamenia every 2 weeks no flowing between periods. Operation February 20, 1920, consisted in dilatation and curettage, biopsy and cauterization of the cervix, supravaginal hysterectomy for chronic pelvic inflammation. Seven months after treatment with radium examination revealed induration in both broad ligaments. The patient was alive with advanced recurrence 3 years after treatment. The illustration shows practically all the tumor found in the biopsy section. It is not unlikely from the outcome in this case that the tumor was more advanced at the time of first admission than the findings indicated. Nevertheless,

a pathologist stated that the lesion was probably not malignant.

CASE 8 (Figs. 15, 16, 17 and 18—Path. 18194.) Mrs. E R, aged 29 years. One normal pregnancy 7 years before admission. Operation September 24, 1930 dilatation and curettage, bilateral trachelorhaphy conservative operation for mild chronic pelvic inflammation. The photomicrographs were taken from the cervical specimens. Three years after irradiation the patient was well.

CASE 9 (Figs. 19 and 20—Path. 19178) Mrs. G C, aged 37 years. Pregnancies 2 full term deliveries the last 15 years before admission 3 abortions. Operation July 4, 1931 consisted in trachelorrhaphy anterior colporrhaphy perineor



Fig 9



Fig 10



Fig 11



Fig 12



Fig 13



Fig 14

Fig 9 Practically normal squamous epithelium on the left side. Carcinoma *in situ* on the right. Note distribution of round cells.

Fig 10 Case 5. Higher power of Figure 9.

Fig 11 Case 5. High power of Figure 10.

Fig 12 Hypertrophied squamous epithelium on the

left. Mass of atypical cells on the right with dense chronic inflammation around it.

Fig 13 Case 6. Superficial atypical epithelium made up of anaplastic cells.

Fig 14 Case 7. Basal layer absent. Poor differentiation.

rhyph supravaginal hysterectomy for chronic pelvic inflammation. The trachelorrhaphy findings are illustrated. Patient well 1 year 4 months after radium treatment. Pathologist's note: "precancerous."

CASE 10 (Figs 11 and 12—Path 10900) Mrs. L. G. aged 33 years. Had had 10 full-term deliveries. She was admitted to the hospital on January 20, 1932, because of intermittent flowing of 2 months' duration. Because of severe pulmonary tuberculosis only cervical biopsy was performed and radium applied. The illustrations were taken from the biopsy sections. The patient was alive with no evidence of cervical disease 1 year 4 months after treatment. Pathologist's note: "chronic cervicitis—*atypical epithelium*."

CASE 11 (Figs 13 and 14—Path 20326) Mrs. A. M. aged 53 years. Pregnancies: 2 full-term, 23 years previous to admission. Menopause had occurred at the age of 48. Operation, January 23, 1932: dilatation, curettage and biopsy because of bleeding of 1 day's duration. The cervix appeared atrophied except for a small area of erosion on the posterior lip. One year and 6 months after treatment with radium the patient was well.

CASE 12 (Figs 15 and 16—Path 20067) Mrs. A. Q. aged 51 years. Pregnancies: 8 full-term, 1 abortion. Complaints were those of prolapse, no abnormal flow or discharge. Operation, July 28, 1932: consisted in dilatation and curettage, bilateral trachelorrhaphy, anterior colporrhaphy, perineor-



Fig 15



Fig 16.



Fig 17



Fig 18



Fig 19.



Fig. 20.

Fig 15 Case 8 This may be an atypical hyperkeratosis, but the poor basal layer, the variability of the cells, and the chronic inflammation point more toward early malignancy especially after considering the following illustrations.

Fig 16 Case 8 Higher power from Figure 15.

Fig 17 Case 8 Another area from the same sections as Figures 15 and 16. At first glance this does not appear to be anything more than a simple erosion. Under higher power (Fig 18) however there is apparent excessive and abnormal activity.

Fig 18. Case 8. High power from Figure 17 Frequent mitoses, pleomorphism, hyperchromatism.

Fig 19 Case 9 On the left the epithelium differentiates fairly well, although the basal layer is not clean cut. The epithelium on the right shows all the characteristics of carcinoma except invasion.

Fig 20 Case 9 High power from Figure 19

Fig 21 Case 10. No basal layer almost no differentiation. Possibly beginning invasion.

Fig 22 Case 10 High power from Figure 21



Fig. 21



Fig 22



Fig 23

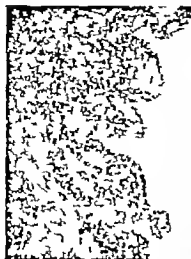


Fig 25



Fig 27



Fig 24



Fig 26



Fig 28

Fig 23 Case

Fig 24 Case High power from Figure 23

Fig 25 Case 2 The extremely dense infiltration with round cells and the atypical activity shown under high power (Fig 26) make this seem to be more than healing erosion

Fig 26 Case 12 High power from Figure 25

Fig 27 Case 23 Some differentiation pseudo-basal layer marked chronic inflammation, numerous mitoses

Fig 28 Case 3 High power from Figure 27 In normal or hypertrophied epithelium and in the epithelium of erosions rarely is it possible to find more than mitoses in a high power field.

rhaply. The trachelorrhaphy section is illustrated in the photomicrographs. One year and 3 months after irradiation the patient was well and examination revealed no abnormality.

CASE 13 (Figs 27 and 28—Path 21167) Mrs. M.S. aged 38 years. Pregnancies a normal labor 14 years before admission and an induced abortion 10 years before. The patient was first seen in October 1932 because of lower abdominal pain, backache bearing down and vaginal discharge, all of 2 years duration. There had been no abnormal

flowing. Operation was advised but not urged. Operation December 29, 1932 dilatation and curettage biopsy and cauterization of cervix anterior colporrhaphy supravaginal hysterectomy for chronic pelvic inflammation. The findings in the biopsy are illustrated in the photomicrographs. The patient was well 11 months after irradiation. Three pathologists did not consider the biopsy sections malignant.

CASE 14 (Figs 29 and 30—Path 21400) Mrs. E.M. 49 years old. The last of her 3 pregnancies



Fig. 29.



Fig. 31



Fig. 33



Fig. 34.

Fig. 29. Case 14. No basal layer numerous mitoses, atypical cells with poor differentiation.

Fig. 30. Case 14. High power from Figure 29.

Fig. 31. Case 15. No basal layer, marked inflammation and atypical cells, but only few mitoses.

Fig. 32. High power from Figure 31.

Fig. 33. Case 16. There is a short stretch of normal epithelium in the lower left corner. Chronic inflammation and early invasion are apparent.

Fig. 34. Case 16. There is no basal layer. The cells differentiate poorly. Mitoses are present.

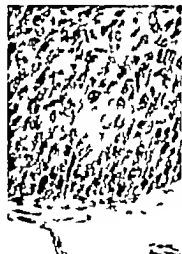


Fig. 30



Fig. 32

had gone to term 20 years before admission. Between December 1931 and March 6 1933 the date of operation she had been seen often because of slight menstrual irregularities and a small fibroid uterus. There was some cervical erosion which healed well after mild cauterizing. Menorrhagia and lower abdominal pain made it advisable to operate. Complete hysterectomy was performed. The routine section of the cervix happened to show the lesion depicted in the photomicrographs. Pathologist a note: no invasion—active epithelium.

CASE 15 (Figs. 31 and 32—Path. 8,423.) Mrs. H. C. aged 34 years. Pregnancies 3 the last, 15 years ago. Operation, May 20 1919 dilatation and curettage trachelorrhaphy, supravaginal hysterectomy for chronic pelvic inflammation. The section

from the cervix was diagnosed chronic cervicitis. In December 1931, 12 years and 6 months after the above operation the patient appeared at another Boston hospital because of a bloody vaginal discharge of 3 weeks duration. Biopsy showed epidermoid carcinoma grade II. Six months after irradiation she was apparently well with no evidence of recurrence. The accompanying photomicrographs were made from the original trachelorrhaphy section, which has recently been re-examined and submitted to others for opinion. All agree that it is 'most suspicious' of early malignancy despite the fact that cancer was not evident clinically until over 12 years had passed. Since it seems impossible for cancer to be present so long before giving symptoms it is conceivable that trachelorrhaphy removed the lesion and that another cancer developed subse-

quently. On the other hand, it could be argued that this lesion was not malignant. We have committed ourselves to a diagnosis of very early cancer in this instance after considerable hesitation. This case is being reported by Dr. R. L. Pearse in a series of supravaginal hysterectomies (3).

CASE 16 (Figs 33 and 34—Path. 14565) Mrs. E. S., 38 years old. She had had 5 children, the last 3 years before admission. At operation, February 16, 1927—dilatation and curettage, cauterization of the cervix, bilateral trachelorrhaphy, anterior colporrhaphy, perineorrhaphy, lysis of peritoneal adhesions, right salpingo-oophorectomy, appendectomy, suspension—tuberculous salpingitis was found. Convalescence was complicated by a sinus in the abdominal wound which did not heal until 9 months after operation. The illustrations are taken from a section of the cervical specimens. We considered the lesion malignant but because of the patient's condition and out of deference to the opinion of a consulting pathologist who unequivocally diagnosed the condition chronic endocervicitis, the patient's cervix received no further treatment. She then failed to respond to follow up letters and was lost. It has recently been discovered that she underwent complete hysterectomy on April 1, 1933 for cancer of the cervix, 6 years and 1 month after trachelorrhaphy and died of the disease in September, 1933. The clinical diagnosis was confirmed by pathological examination.

In 5 of the 16 cases cited malignancy was suspected before operation—in 4 instances because of abnormal flowing and once because of leucorrhoea after the menopause. The gross appearance of the cervix, with but one exception (Case 6) did not suggest the possibility of cancer any more than the average patulous cervix. In reviewing the records of the cases cited it is interesting to note that 9 were found to have chronic pelvic inflam-

mation. Another had tuberculous pelvic inflammation. Three other interesting points are observed. First, the large number of pregnancies that 3 of the younger patients had (6 before the age of 27, 5 before the age of 27 and 10 before the age of 32) second, the long intervals between pregnancy and the finding of the above lesions (over 5 years in 11 cases, over 10 years in 8 cases) and third, the long intervals between the finding of early lesions and the appearance of cancer clinically (Cases 1, 2, 16 and (?) 15).

SUMMARY

Sixteen cases that have been outlined and illustrated show in our opinion very early malignant lesions of the cervix. They are presented not only in corroboration of Schiller's work but also because they are such as may fail to be considered seriously by those not constantly studying gynecological pathology.

We are grateful to Dr. W. W. Boyd, Dr. S. C. Graess, and Mr. Richard W. St. Clair for their photomicrographs.

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CLINICAL MANIFESTATIONS OF THE CHROMAFFIN CELL TUMORS ARISING FROM THE SUPRARENAL MEDULLA

SUPRARENAL SYMPATHETIC SYNDROME

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IN the consideration of the syndromes produced by certain lesions of the suprarenal glands little or no attention has been given to the clinical states associated with the chromaffin cell tumors. The literature regarding these tumors is mostly foreign and the contributions have been chiefly from the pathological point of view. These neoplasms have been generally viewed as being extremely rare and of little clinical significance. It is the purpose of this paper to present first, a complex group of signs and symptoms associated clinically with the pheochromocytoma of the suprarenal medulla, second the report of a case illustrating the syndrome third a detailed analysis of the reported cases together with the facts of clinical importance related to them.

THE SYNDROME

The stimulus for this study of the clinical syndrome associated with the pheochromocytoma of the suprarenal medulla was initiated by our failure to make a correct clinical diagnosis in a patient who presented an extraordinarily dramatic group of signs and symptoms which went uninterpreted until after the necropsy when the diagnosis was established. Even after the necropsy, the pathological diagnosis was made with considerable study. It was for these reasons that we began an intensive review of the medical literature relating to these tumors. We found that in a majority of the reported cases in which complete histories and physical examinations were given the patients manifested signs and symptoms indicating an instability of the sympathetic nervous system, often including *paroxysmal sympathetocolonia*. Chief among these signs and symptoms were *hypertension* or *paroxysmal hypertension*, *glycosuria* and *periodic attacks of tachycardia* *vasoconstriction* and *vasodilatation of the periph-*

eral vessels, as shown by *pallor* followed by *flushing of the skin*, *headaches*, *nausea*, *vomiting* nervous manifestations with *sensations of constriction in the epigastrium*, *dyspnea*, *suffocation*, or *choking*. When subjected to surgical procedures these patients, with few exceptions, manifested an unusual *susceptibility to shock*. *Pulmonary edema* and *hypertrophy of the heart* were the most frequent associated pathological findings. The deep seated site of the organ involved makes the clinical perception of the *tumor*, which acts as the causative lesion, a variable finding depending upon the size of the tumor and the thoroughness of the physical examination.

CASE REPORT

A Jewish woman aged 45 years referred by Dr. Carl Conn of Los Angeles, entered the Hollywood Hospital with the following complaints. For the last 3 years she had had frequent attacks of nausea, vomiting, dizziness, palpitation of the heart, profuse perspiration, pallor then flushing of the skin followed by severe headaches. These attacks most often occurred when the patient first arose in the morning. They also occurred unexpectedly during the day. Two weeks previously Dr. Conn had discovered a mass in the right upper quadrant of the abdomen. The patient had never noted pain in the region of this mass.

Seven years previously she had been operated upon by Dr. Conn for a fibromyoma of the uterus which was removed. At that time the dismissal note indicated that when the patient left the hospital she was apprehensive about her heart because of a slight palpitation. The blood pressure was 140/78 millimeters mercury. There were no palpable masses in her abdomen.

Physical examination revealed the following. The general appearance was that of a normal woman of her stated age. There were visible pulsations of the large vessels of the neck. A blowing systolic murmur was present heard best in the aortic area. The blood pressure was 170/80 millimeters mercury and the pulse rate was 60. The temperature range throughout 48 hours observation did not vary from normal. There was a rounded smooth slightly movable, firm mass in the right flank, palpable and



Fig. Roentgenogram, with ureteral catheters in place, showing large tumor in the region of the right kidney.

visible also. This mass appeared to be about the size of a large grapefruit.

Cystoscopic examination was made and ureteral catheters passed without difficulty to both kidney pelves (Fig. 1). Urine specimens were obtained from each side. Pyelograms were made which showed the right kidney to be tilted and rotated through 90 degrees with an enlarged pelvis (Fig. 2). There was an ovoid shadow at the outer border of the kidney parenchyma in the roentgen plate. Following the cystoscopic examination the patient revealed an unusual degree of weakness and perspired profusely.

Roentgenological examination of skull, chest, and bones showed no evidence of metastases or other abnormalities. Urinalysis revealed glycosuria, ooeplus, and a trace of albumin. Phenolsulphonphthalein elimination was 15 per cent right, and 30 per cent left, in 15 minutes after intravenous injection. Gram's stain of the urine from both kidney pelves revealed no abnormal cellular elements and cultures showed no growth. The blood count was erythrocytes 5,550,000, white cells 10,700 with 74 per cent polymorphonuclears, hemoglobin 87 per cent (Sahli).

A tentative diagnosis of hypernephroma was made and it was decided to make a surgical exploration of the right kidney region. Accordingly on the morning of October 23, 1931 the patient was given $\frac{3}{4}$ grain of ephedrine hypodermically and taken to the operating room where a spinal anesthetic was given using 150 milligrams of cocaine. The patient was placed on her left side in the overhand swimming position and the kidney "lift" was raised. She

immediately became ashen in color and covered with sweat. She was intensely nauseated and vomited for several minutes. The blood pressure was taken at once and systolic readings above 300 millimeters mercury, the upper limit of the instrument's calibration were recorded (Fig. 3). With the manometric reading at 300 millimeters mercury pulsations could still be loudly heard over the brachial artery below the cuff of the blood pressure instrument. The diastolic reading was 240 millimeters mercury. No incision was made and the patient was returned to her room. The pulse was then rapid and weak, her hands were cold and clammy, she was conscious, coughing and expectorating brown mucus. The temperature was 101.6 degrees F, pulse 135, respiration 35.

Two hours later the blood pressure was 230/150 millimeters mercury, pulse rate 128 and a slight exophthalmos was noted. At 12 noon the blood pressure had fallen to 180/120 millimeters mercury. The pulse was 132 and the patient vomited brownish fluid flecked with bright blood. The body and face were very warm and intensely red. At 2:30 p.m. the chest was full of rales and a bilateral systolic murmur was observed. The patient complained of dizziness. At 4:00 p.m. the electrocardiogram showed a sinus tachycardia with a pulse of 140. The blood pressure was 130/80 millimeters mercury. The blood pressure then gradually fell and was observed to be 120/60 millimeters mercury at 9:00 that evening. The urine output was only 350 cubic centimeters in this 12 hour period notwithstanding the administration of intravenous glucose. The following morning when the temperature was 104 degrees F the arterial tension had become 200/95 millimeters mercury. The pulse rate was 130. During the following day the patient suffered from a severe attack of pulmonary edema. Cyanosis gradually became more in evidence. Nausea and vomiting persisted. The blood pressure fluctuated but gradually fell. Late in the evening her condition grew much worse, the abdomen became distended, temperature 106.4 degrees F, pulse weak, respirations labored. She became comatose. Early the following morning the temperature had risen to 107 degrees F, the pulse was barely perceptible at the wrist, and the patient's lungs and mouth were filled with mucus. The patient expired at 7:20 a.m. Necropsy was performed at 9 a.m. by Dr. V. L. Andrews, pathologist of the Hollywood Hospital.

Necropsy report. The body was that of a well developed and well nourished white female whose apparent age was 45 years. The skin was white and soft. The distribution of hair was normal. The thyroid was congested but normal in size. The lungs were dark colored and crepitant. Cut section showed congestion, scattered hemorrhages, and edema. The heart musculature was firm, dark colored, and hypertrophied. The blood vessels were everywhere soft and elastic. The liver was dark colored. Its cut section revealed minute scattered hemorrhages. There was present a generalized

cloudy swelling which obscured the lobulations. Except for the absence of the uterus the rest of the abdominal contents showed no deviation from normal. When the calvarium was opened the meninges were found to be dry. Section revealed no abnormality of the brain tissue. The pituitary body was normal. The right kidney was pushed forward outward and downward by a mass above and behind it. This kidney was smaller than normal. The pelvis held 25 cubic centimeters. The kidney tissue was compressed and showed cloudy swelling. The ureter was dilated to twice its normal diameter in its upper third. There was no inflammation in the kidney tissue or pelvis. The mass behind the right kidney replaced the right suprarenal gland.

The tumor. It was an elongated fused mass of lobules which separated readily into two lobes (Fig 4). The upper lobe which occupied the position of the suprarenal gland measured 14.5 centimeters by 8 centimeters by 6 centimeters. The lower lobe passed down behind the kidney pushing it forward and down. It was very lobulated and measured 12 centimeters by 8 centimeters by 6 centimeters. Both lobes were quite cystic. A large amount of clotted and fluid blood was found in cystic cavities within the lower lobe. Section of the upper lobe showed some clotted blood in cystic cavities but here the tumor tissue was more solid and uniform. The growth itself had a beefy red color and was soft. One could not identify cortical tissue. The surface layers were a little firmer to palpation than were the deeper portions but they revealed no difference in color. The entire mass was definitely delimited, shelling out readily from its bed. The tumor did not invade any of the surrounding tissues. A single artery and its accompanying vein connected the kidney to the tumor mass. Three small arteries supplied the tumor from the renal artery and many others ran into it from the aorta and the neighboring vessels.

Microscopic report. Sections of the thyroid gland showed almost complete destructions of the thyroid tissue which had been replaced by fibrous and lymphoid tissue. The blood vessels of the thyroid were prominent, large and deeply congested. The left suprarenal was normal. There was no evidence of nephritis in either kidney.

Microscopic section of the tumor mass showed it to be made up of structures in gland formation in which the lining cells assumed a low cylindrical form (Fig 5). Basement membranes were everywhere intact. In places the formation was in long strands giving the impression of cords of cells. There was no visible fibrous framework. The prevailing type of cell was considerably more differentiated than that ordinarily seen in the medulla. In the hematoxylin-eosin stained sections the cytoplasm of these large cells was pink and granular, the nucleus oval and light staining (Fig 6). There was an absolute lack of mitotic figures. Throughout the tumor mass were large blood spaces and cysts.



Fig 3. Pyelogram showing dilatation of the pelvis of the right kidney. Note ptosis of kidney and tumor shadow.

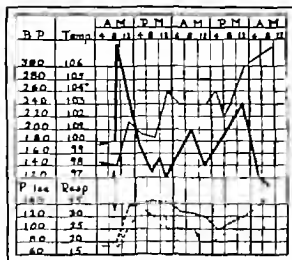
Chemical examination. A portion of the tumor was removed immediately and a quantitative chemical determination for epinephrine according to the method of Folin Denis, and Cannon yielded 3 grams of this drug to 100 grams of tissue. Numerous color reactions were used as qualitative tests of this extract and were all confirmatory for epinephrine.¹

Pathological histological diagnosis. Pheochromocytoma. This diagnosis was confirmed by Dr C F Geschickter of Baltimore and Dr W J Merle Scott of Rochester New York.

SUMMARY OF CASE

The patient was a middle aged woman with a large retroperitoneal tumor thought to be an hypernephroma. Her clinical story was misinterpreted as being neurotic or climacteric manifestations. It is now revealed to have been a very characteristic and significant history of paroxysmal sympathicotonia. A surgical exploration was planned. A spinal anesthetic was given but no surgical incision was made. From the time the patient entered

¹The chemical determinations were carried out by Miss Hall, hospital biochemist, working under the direction of Dr V L Andrews, of the Hollywood Hospital.



— Blood Pressure — Temperature
Pulse — Respiration

Fig. 5. Chart showing fluctuations of blood pressure, temperature, pulse and respiration. Arrow indicates the time of the patient's entrance to surgery.

the operating room until her death the extraordinary succession of events which took place could not be explained upon the basis of any syndrome known to us.

At necropsy a large cystic chromaffin cell tumor weighing 1000 grams was found replacing the right suprarenal gland (Fig. 7). Subsequent quantitative chemical analysis of a portion of the tumor proved it to contain the enormous quantity of over 2 grams of adrenalin per 100 grams of tissue.

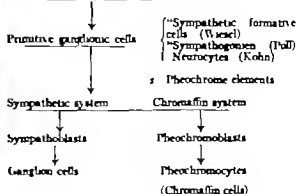
DEVELOPMENTAL ANATOMY

The nature of these neoplasms may be better understood by briefly considering the embryological development of the suprarenal glands. These glands are developed from two sources. Their cortical portion is derived from the mesoderm. The medulla is ectodermal in origin since it is derived from ganglions of the sympathetic system.

The developing ganglions become differentiated either into the sympathoblasts of the sympathetic system or into the pheochromoblasts of the chromaffin system. Sympathoblasts develop into ganglion cells. Pheochromoblasts are destined to give rise to the

pheochromocytes, known also as chromaffin cells. This may be expressed diagrammatically

Neuroectoderm of the neural crest



The primitive pheochrome elements become separated from the ganglions and migrate to the region of the cortex subsequently aggregating in its center. In this migration sympathoblasts also are carried along with these pheochrome cells and give rise to the ganglion cells within the gland. Similarly it is an interesting fact that some of the pheochrome cells become diverted from their course and instead of entering into the formation of the suprarenal medulla they become permanently associated with some of the prevertebral and peripheral sympathetic ganglions as small masses of accessory medullary tissue. To these Kohn gave the term paraganglions.

The pheochromoblasts in the suprarenal medulla as well as those within the paraganglions probably do not become finally differentiated into the mature pheochromocytes until after birth. At this time these cells which are now mature undergo a chemical change which makes them assume a brown color when treated with chrome salts, such as potassium bichromate. Hence these cells are called chromaffin or pheochrome cells. No other tissue in the entire scale of animal life gives this reaction. It is these specific cells which produce adrenalin. The chromaffin system consists of these cells located in the medulla and in the paraganglionic tissue. That tumors may arise from these cells is now well established. Formerly these tumors were described by various names viz sarcoma, angiosarcoma, perithelioma, carcino-ma et

cetera, until Alerais and Peyron in 1908, described a chromaffin cell tumor originating from a paraganglioma in the sacrococcygeal region and gave the name paraganglioma to all such tumors wherever they are found. Pick, however, in 1912, called attention to the fact that these tumors should be named after the predominating type of cell namely the pheochromocytoma. He suggested that these tumors arising from the suprarenal medulla itself should be called pheochromocytomata and that the term paraganglioma should be reserved for those arising outside the main gland, that is, from the paraganglions.

CLINICAL ANALYSIS OF REPORTED CASES

We have reviewed the reports of 60 cases which have been considered by various authors to have been chromaffin cell tumors arising from the suprarenal medulla. One case however of extra suprarenal pheochromocytoma (paraganglioma) is included in this review due to its location in the adjacent area, the size of the tumor, and the significant clinical report. There were 8 cases which were either malignant as shown by metastases, or were associated with definite malignancy in other organs (Table II). In the majority of these cases which showed malignant neoplastic growth, no clinical information was given but merely the pathological report of the necropsy findings. Five of the early reported cases (Frankel, Percy Berdez, Robert, Manasse—1893) which have been considered by certain authors to have been pheochromocytomas do not in our opinion, contain sufficient evidence definitely to establish their identity. There were 6 cases mentioned in the literature on which no data were presented. Nineteen of the remaining cases did not have clinical histories and physical examinations in their reports (Table I). There were only 23 cases of benign chromaffin cell tumors of the suprarenal medulla with clinical histories and examinations reported in the literature. Several of these case reports are extremely brief and may be conveniently presented in tabular form (Table III). The majority of this group showed definite evidences of instability of the sympathetic nervous system. A few, however, with detailed



Fig. 4. Photograph of pheochromocytoma replacing the right suprarenal gland.

reports, were overshadowed by complications and no conclusions regarding the clinical manifestations could be drawn.

We have summarized some of the most typical cases in detail due to their importance in evaluating the clinical manifestations associated with the pheochromocytomata.

Labbe, Tinel, and Doumer, 1922, deserve the credit for reporting a classic case in which the complete clinical and pathological observations were recorded in detail, thereby contributing the first case which may be used as a basis for a study of the typical clinical states manifested by the chromaffin cell tumors.

CASE 1. Mme. L. aged 28 years complained of attacks of nausea and vomiting followed by characteristic nervous manifestations, which had recurred at irregular intervals for several months. These attacks had gradually become more excessive, recurring three or four times a week, often when the patient first awoke, or soon after breakfast, but also at other times during the day. There was no pain

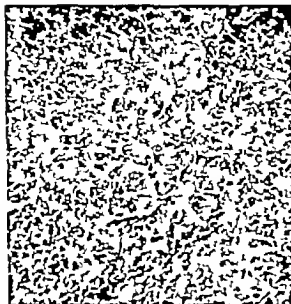


Fig. 5. Low power photomicrograph of tumor

with the attacks. The attack began as a general malaise, coldness, tingling of the extremities, face becoming pale, appearance of vasoconstriction of hands and feet and a feeling of a constriction in the epigastrium with nausea followed by vomiting. The heart rate became accelerated into a severe tachycardia which was followed by vasodilatation of the face, neck and chest with profuse perspiration. The extremities were cool and the patient was cyanosed. During the attack the urine was suppressed but the secretion reoccurred a few hours later. Physical examination revealed a paroxysmal hypertension which varied from day to day and from hour to hour. The systolic pressure would range from 280, 270, 260 millimeters mercury down to 160, 140, 130, 125 millimeters mercury. Two readings outside of the attacks were 150 and 100 millimeters mercury. The patient soon developed a persistent glycosuria. The oculocardiac reflex was accentuated. She was dismissed from the hospital with a diagnosis of either non-toxic hyperthyroidism or a neuro-circulatory manifestation. However she returned 3 months later with an acute attack of pulmonary edema. The patient stated that during the interval the attacks had increased in severity and in frequency occurring nearly every day. Intermittent fever now persisted from 39.5 degrees C. to 40 degrees C. rarely as low as 37 degrees C. During her stay in the hospital she had three attacks of pulmonary edema. She died in a severe paroxysmal attack with acute pulmonary edema.

Necropsy. The heart weighed 340 grams. It was apparently normal. The lungs were filled with fluid and the liver showed small foci of hemorrhages. The kidneys appeared normal, and on section no trace of sclerosis or glomerular lesions could

be found. Thyroid and ovaries appeared normal in the gross, but microscopic study of the thyroid gland showed considerable evidence of hypersecretion—increased in volume of colloid material and increase in number of vesicles. The left suprarenal was replaced by a tumor the size of a small orange. Histological diagnosis was paraganglioma of the suprarenal medulla.

Mayo 1927 reported an extra suprarenal pheochromocytoma (paraganglioma) which was successfully removed at operation.

CASE 2. A woman, aged 30 years, suffered intermittently from peculiar acute attacks characterized by the sudden onset of discomfort in the precordium, headache, generalized pallor, cold and clammy skin and a peculiar choking sensation followed by nausea and vomiting. Cough frequently occurred during the attack with expectoration of frothy saliva frequently tinged with blood and associated with signs of pulmonary edema. Observation and study showed that these attacks were in the nature of intermittent paroxysmal hypertension (the systolic blood pressure often exceeded 300 millimeters mercury and 180 millimeters mercury diastolic) that they were attended by generalized vasoconstriction or a spasm, as evidenced by pallor of the skin and complete obliteration of capillaries of the nail folds during attacks. Exploratory operation revealed "An oval mass (about 6 by 4 centimeters) situated retroperitoneally behind the tail of the pancreas on the mesial side of the left kidney and impinging against its upper pole." The tumor was successfully removed. In a recent communication the patient is reported to have been free from symptoms to date. The pathological diagnosis at that time was "malignant blastoma" but subsequent studies by Dr. Macarty and others, have caused this tumor to be regarded as a pheochromocytoma arising from the chromaffin system (paraganglioma). Through the kindness of Dr. Mayo we had the opportunity of studying sections of this tumor in collaboration with Drs. V. L. Andrews and Brem Zeller and Hammack, pathologists.

This highly interesting case of Dr. C. H. Mayo is again a typical case of the suprarenal sympathetic syndrome. In this case the author made the unique clinical observation that the patient's entire clinical syndrome was in some way mediated through the sympathetic nervous system and that the causative lesion was probably a tumor intimately connected with this system.

Rabin in 1929 reported a typical case of this syndrome and added a critical review of the histological constitution and associated clinical conditions in 30 of the reported cases. This author stated that "Outstanding in this

review is the large percentage of cases associated with hypertension and signs of vasomotor or autonomic instability. The occurrence of hypertension at an early age, the inability of so many of these patients to withstand minor operative procedures and the sudden death without demonstrable cause in this case appear also to be more than simple coincidences."

CASE 3. A Polish woman, aged 45 years, had been suffering for many years from nervous manifestations similar to exophthalmic goiter. These symptoms were hypertension, palpitation, tremor, dyspnea on exertion, cough, nausea, vomiting and fever. Physical examination revealed a blood pressure which fluctuated from 256 systolic 180 diastolic to 177 systolic and 122 diastolic millimeters mercury. Finally meningeal signs developed and the patient died in coma. Necropsy revealed an advanced hypertrophy of the heart, generalized arteriosclerosis, and a pheochromocytoma of the medulla of the right suprarenal gland. A delayed quantitative chemical analysis of this tumor proved it to contain 1.5 milligrams of epinephrine per gram of tissue. The thyroid, brain and meninges were normal. The right kidney on section showed no abnormality. The left revealed a few sharply defined hemorrhagic areas within the cortex.

Vaquez, Donzelot and Geraudel 1929 described a typical case of the "suprarenal sympathetic syndrome" in which deep radiation was unsuccessful. Though at first the patient's symptoms greatly subsided they returned later more severe than ever. Another fact of equal importance is that the attacks of hypertension which were at first intermittent and paroxysmal finally developed into a permanent hypertension.

CASE 4. A man aged 37 years, had been suffering from acute painful "crises," paroxysmal in character. Just as a complete physical examination had been finished the patient suddenly declared, "now my attack is beginning." The whole body became suddenly pale and the face had a mournful appearance. The pulse rate increased rapidly from 70 to 100 in a minute and the aortic second sound previously normal, became greatly accentuated. The sphygmomanometer had not been removed from the arm; the pressure was taken at once. It had passed from 140/80 to 300/80 millimeters mercury. The height of the attack was reached in about 3 minutes when it began to decrease. During a similar previous attack the patient had suffered a hemorrhage into the retina of the right eye, which caused a gross diminution in visual acuteness. He developed an acute attack of pulmonary edema with



Fig. 6 High power photomicrograph of pheochromocytoma showing details of the cellular structure.

frothy sputum tinged with blood. These attacks recurred almost daily. Following a particularly violent attack, the patient often had an intense diarrhoea with epiphora, and also an albuminuria. The complete physical examination which was made several times outside of the attacks did not reveal the existence of any objective symptoms worthy of note. As the patient refused surgical exploration he was referred for radiological treatment. The result of irradiation in the lumbar region was at first very gratifying but unfortunately the patient's attacks recurred after several months with even greater severity. The hypertension which was at first paroxysmal had at this time become permanent (210/130 millimeters mercury). These attacks sometimes included painful abdominal colic similar to lead poisoning; at other times the discomfort was confined to the thoracic region, while often violent headache predominated. Finally the patient became completely bewildered, agitated, and blind. He could not sleep, had no appetite and had continual nausea and vomiting. Soon the patient became comatose and died. Necropsy revealed hypertrophy of the left ventricle of the heart and a cystic chromaffin cell tumor (7 by 6 by 5 centimeters) which was situated in the right suprarenal gland.



Fig. 7. Sagittal section of tumor showing cystic and necrotic areas.

Shupley 1929 reported another typical case of the suprarenal sympathetic syndrome in which two operations were necessary to find and remove the tumor. Notwithstanding the fact that the patient suffered from severe shock and developed alarming respiratory symptoms, she survived the operations and was cured of her attacks.

CASE 5. The patient was a young woman, aged 26 years, who for the past 10 years, had suffered with periodic vasomotor attacks characterized by a hot flushed feeling in both arms followed by a sensation of tightness and compression over the heart, which would beat forcibly. There was a feeling of difficulty in breathing and a swelling in the neck. This was followed by nausea and often vomiting. These attacks increased in violence and in frequency and severe occipital headache was an increasingly troublesome symptom. Between attacks the patient was apparently perfectly normal with a blood pressure reading of 120 millimeters mercury systolic and 90 millimeters mercury diastolic.

Examination during the attack revealed a steadily increasing hypertension which at one time went as high as 260 millimeters mercury systolic and beyond the point where the instrument would register. "During the height of the attack there was marked pulsation of the vessels of the neck, the

jugulars were prominent, the head, feet, knees, and nose were quite cool to the touch, the face a little flushed, there was marked tremor of the hands, the respirations were shallow and increased to 36, and pulse rose gradually to 110 and fell to 76 with the fall of blood pressure.

The left suprarenal gland was explored and found normal but a tumor was palpated in the right suprarenal region. Due to the inability to remove this tumor through the initial incision it was decided to close the wound and to reopen the abdomen at a later date.

Thirteen days later the abdomen was reopened and a tumor was found replacing the right suprarenal gland. The tumor was removed, the wound closed, and the patient was returned to her room quite shocked. The blood pressure was very low for several hours. She developed a well marked grayish cyanosis, and the respirations were rapid and shallow. At the most critical period she spat up a small quantity of frothy sputum containing some bright red blood. Finally these symptoms subsided but her blood pressure remained low, ranging between 95 systolic, 65 diastolic, and 110 systolic and 70 diastolic millimeters mercury. The patient reported herself, 10 months later as entirely well and free from attacks. The pathological diagnosis of the tumor was "paraganglioma of the suprarenal medulla." It was found to contain an excessive amount of epinephrine.

Labbe, Violle and Azerad 1930 described their excellent observations on a clinical case of "paroxysmal sympathicotonia" which had been followed for 12 years. Finally at the age of 29 the patient died from cerebral hemorrhage.

CASE 6. This patient had been evacuated from the battle front in 1918 with an illness thought to be chronic nephritis. But from this time on the variations of his arterial tensions held the attention of his physicians, and caused a great deal of discussion. His blood pressure ordinarily around 160/100 millimeters mercury was subject at times to paroxysmal attacks during which the systolic pressure increased to 350, 300 millimeters mercury or even higher. These attacks began with a feeling of apprehension, pallor, haggard eyes, and dilated pupils. Then followed violent palpitations, with an increase of the usual tachycardia, considerable cardiac irritation, and increased arterial tension. These attacks usually lasted for an hour and ended with sweating. They were repeated at close intervals, sometimes occurring twice in one day. The patient's urine contained some albumin, 0.06 to 0.12 centimeter per liter and his azotemia was slightly increased, 4.5 centimeters per 1000 cubic centimeters. Finally evidences of a cerebral hemorrhage became manifest and the patient died in coma.

Necropsy. There was a chromaffin cell tumor of the right suprarenal body the size of a small orange.

TABLE I.—CASES WITHOUT HISTORY AND PHYSICAL EXAMINATION

Author Date	Age Sex	Tumor location and size	Clinical diagnosis	Pathological diagnosis	Remarks
Manasse 1906	70 M	Left Hem. egg	None	Hyperplastic med. tumor	First case in which the chromaffin reaction was demonstrated
Marchetti 1904	3 M	Bilateral Poa	Typical fever	Hyperplasia sup. med.	The first case with bilateral occurrence
Suzuki 1909	62 M	Right 10 cm	Fractured femur Bronchial asthma Thrombophlebitis Myocarditis Pulmonary edema	Chromaffin cell tumor Thrombosis of femoral and iliac veins (left) Abscess of kidney Lobar pneumonia	The solution in which the tumor was placed turned green and gave adrenal chemical reactions
Suzuki 1910	60 F	Right 1½ cm	Neurofibromatosis Tuberculosis right wrist Inguinal hernia Kyphosis of spine	Chromaffin cell tumor Chronic tuberculosis of lungs, left suprarenal, intestines, peritoneum, right hand and spine	The clinical manifestations of such small nodules would have undoubtedly been overshadowed by the coexisting complications
Suzuki 1910	83 F	Right 1 cm.	Emphysema of lungs Chronic bronchitis Pneumonia	Paraganglioma and hypoma Pneumonia Arteriosclerosis	The author believed this nodules was composed of fat cells plus chromaffin cells. Only a few cells showed chromaffin reaction
Hedinger 1912	34 F	Left 10 cm	Cervical abortion (fourth month) Anemia	Struma nodularis cystica supracapsularis Streptococcus peritonitis	The fixing solution when tested showed large quantities of adrenalins
Kawashima 19	33 F	Left Apricot	Postpartal fever following delivery of a 6 mos. macerated fetus	Chromaffin cell tumor Thrombophlebitis right ovarian vein Struma postpartalis F. sty heart Neurofibromatosis	The author believed the tumor was of malignant nature. There were no metastases
Hilde 1913	43 F	Left 3 cm Right 2 cm	Myocardial degeneration	Chromaffin cell tumor Small white kidneys Cardiac hypertrophy with thrombosis of left ventricle Pulmonary edema	This author observed a case in 700 necropsies
Wegelin-Bern 1913	39 F	Right 3 cm	Chronic pulmonary tuberculosis	Pheochromocytoma Subendocardial thrombosis Myocardial fibrosis Rouleau effect	Extract from tumor gave strong chemical reactions of adrenalins
Thomas 1915	80 F	Left 4-4½ cm.	Pulmonary embolism	Chromaffin cell tumor Fibro endocarditis Hypertrophy left heart Hydrothorax Pulmonary infarct	This aged patient was seen terminally but the author stated that there was nothing in the clinical history suggestive of hyperadrenalism
Bergstrand 1920	40 F	Right 8-9 cm	Infantia	Pheochromocytoma Hypertrophy of heart Pneumonia	The history before the onset of pneumonia was not given
Laguarda-Lavastone and Anbertine 1908	33 M	Right Poa	Pulmonary tuberculosis Cachexia Melanoderma with no pigmentation + anemia (H. P. 142)	Medullary adenoma of suprarenal capsule Advanced pulmonary tuberculosis	The chromaffin reaction was not demonstrated. The author believed this tumor had its origin in chromaffin tissue but in no place was the tumor connected with the medulla of the gland
Reimer 1917	24	2 cm	Addison's disease	Paraganglioma of suprarenal capsule	This was probably cortical tumor
Katschura-Aachberger (Paul—1911)	7 F	Bilateral Right 200 grains Left 100 grains	Cardiac insufficiency Hypertension Nephrosclerosis	Chromaffin cell tumor Hypertrophy of heart (noted) Small white kidneys	The brief history indicating periodic attacks of dizziness and headaches was perhaps insignificant in this case
Paul 1911	33 F	Right 85 grains	Stroke from poison Acute pulmonary edema Glycosuria	Chromaffin cell tumor	This patient was known to have suffered from angina-like attacks
Paul 1911	34 M	Right 6 cm	No clinical diagnosis Pressure symptoms in suprarenals Cyanosis, vomiting	Chromaffin cell tumor Hypertrophy of heart Large kidney but not diseased	The author regarded case as acute epinephrine poisoning
Julian (Paul—1911)	3 F	Left 5 cm	Normal delivery died in shock	Chromaffin cell tumor Moderately enlarged heart	Agua showing great susceptibility to shock
Paul 1911	33 M	Left 250 grains	Myocarditis, emphysema, cirrhosis of liver Hypertension	Chromaffin cell tumor Cirrhosis of liver Acute pulmonary edema Hypertrophy of heart Generalized arteriosclerosis	Fixing solution was tested immediately for adrenalins and found to be positive
Paul 1911	6 F	Left 3 cm.	None	Chromaffin cell tumor Lobar pneumonia Enlarged heart Thrombosis of inferior vena cava Cholecystitis	

TABLE II—CASES WITH MALIGNANT NEOPLASTIC TUMORS

Author Date	Age Sex	Location—size Primary tumor	Clinical diagnosis	Pathological diagnosis
Wald 94	5 F	Left 6-4 cm	Abdominal tumor Asterism	Neuroblastoma with metastases to liver, kidneys, suprarenal and lymph glands Osteosarcoma Paraneoplasia
Berchauer 94	11 M	Right cm	Neuroblastoma Epiphysis Large tumor of scrota	Neuroblastoma with metastatic degeneration Tumor in region of crura squamæ connected anteriorly with abdominal tumor size of chick's head Paraneoplasia
Harbata 1911	47 M	Left 6-7 cm	Abdominal neoplasm	Hypertrophied suprarenal kidney ad. extending from space of them to diaphragm with metastases to liver and lungs Cystadenoma of the pancreas Hemangioma? Chromaffin cell tumor
Bonassant et al. 1917				Suprarenal paraneoplasia with metastatic pericarditis
Rosen and Barry 1930	10 M	Left cm	Neuroblastoma Lobar pneumonia Palpable tumor in region of right kidney	Acute lobar pneumonia Pneumothorax carcinoma (right) lumbar region Neuroblastoma Colloid adenoma thyroid gland Septicæmia hæmaturæ Atherosclerosis of aorta and thrombosis left ventricle of heart Paraneoplasia
King 1911	10 M	Bilateral Left—5 cm Right—smaller	Neuroblastoma nodules (biopsy) Secondary carcinomas	Malignant pheochromocytoma with metastases in liver, lungs, bowel, bones, skin, and aortic gland
Lazarus and Eisenberg 1932	58	Bilateral normal size	Adenoma of thy. and gland Sarcoma of the gum (biopsy)	Papillary adenocarcinoma of the thy. 1 gland without metastases Paraneoplasia (suprarenal) malignant in generalized metastases
Lazarus, P 1930	6 M	Bile oval Right 9- Left 10- cm	General carcinoma	typical hypertrophied (showed even lessable chromaffin reaction)

*No chemical microchemical given

Additional pathological findings were Hemorrhagic exudate in lungs, hypertrophic dilatation of the left ventricle of the heart, and chronic nephritis with glomerular sclerosis of mild degree

Porter and Porter 1930 described another case of suprarenal sympathetic syndrome in which surgical intervention was successful. In this case a clinical diagnosis of a probable chromaffin cell tumor was made purely on the basis of the clinical symptoms. This diagnosis however was not confirmed by two pathologists at that time but subsequent studies have undoubtedly established the diagnosis of pheochromocytoma. Drs. Porter and Porter obligingly permitted us to study sections from this tumor in collaboration with Dr. V. L. Andrews.

CASE 7. A man, aged 39 years, complained of peculiar attacks occurring apparently without reason at irregular intervals. Gradually the patient noticed that by assuming certain positions he was able to produce them at will. Within a few minutes after assuming the position the attack was ushered in by a peculiar sensation in his epigastrium. His systolic blood pressure would rise from 150 to 200

millimeters mercury or more within a period of 90 seconds. His heart would slow down to about 45 with an unusual, forcible beat, sufficient to shake the bed or chair that he was occupying. His color was ashen and he "felt terrible." As the months passed, mild renal degeneration signs gradually manifested themselves. In addition mild cardiac embarrassment was noticed, shown by slight dyspnea on exertion, occasional tendency to tachycardia following the "attacks" and a very greatly increased disability and discomfort following the period of hypertension. Exploratory laparotomy revealed a movable retroperitoneal tumor above the right kidney. The tumor was removed with little difficulty and without much hemorrhage. The patient was put to bed in a state of severe shock, which in spite of active medication, continued for more than 24 hours. The patient recovered however and has been free from his symptoms up to the present time.

ANALYSIS OF OTHER REPORTED CASES

Lazarus and Eisenberg 1932 reported 2 cases. One was associated with malignancy (Table II). The details of this case have been more completely described in a later publication. The other case was that of a woman aged 58 in which the patient's symptoms were all referable to the genito-urinary tract

(see Table III) The history in this case did not show any evidence of the syndrome here described although careful observations were recorded

Hick has recently reported a case which he describes as a "suprarenalin producing pheochromocytoma of the suprarenal gland" (Table III) The tumor, however, was extra suprarenal "attached to the left suprarenal gland by a short fibrous pedicle" The microscopic diagnosis was "pheochromocytoma in the region of the left suprarenal gland" According to Pick, this tumor would be classed as a paraganglioma

Other reported cases of benign chromaffin cell tumors unassociated with malignant neoplastic growths did not contain clinical histories and physical examinations In the literature these cases were found in pathological reports of necropsy findings and for that reason only the clinical diagnoses were given The essential information in these cases can be given in tabular form No conclusions, however, regarding the clinical symptomatology can be inferred (Table I)

The pheochromocytomata as has already been shown are benign tumors and do not give rise to metastases However it is probable that the more undifferentiated pheochromoblastic type of cells may give rise to the rare malignant tumors sometimes called malignant pheochromocytomata The case of King illustrates this point The original suprarenal tumor showed cells which took the chromaffin reaction but the metastatic growths did not show this reaction with the exception of a few scattered cells The metastatic cells also appeared to be much less differentiated in type than those showing the chromaffin reaction found in the original tumor For these malignant tumors the term pheochromoblastoma would probably be more appropriate

The cases with malignant neoplastic growth as evidenced by metastases or associated with definite malignancy in other organs are given in tabular form None of these cases presented clinical symptoms resembling the syndrome here described (Table II)

It is difficult to evaluate the reports of the earlier cases of supposedly chromaffin cell

tumors which were reported under a different histopathological diagnosis and in which neither histories nor physical examinations were available In fact many of the cases which have been considered by certain authors to have been chromaffin cell tumors were doubtful even as to the pathological identity of the tumors It is possible that one of the earliest cases of chromaffin cell tumor described was that of Frankel (1886)

A young girl aged 18 years, who had been suffering from attacks of cardiac palpitation, anguish, dizziness, and headache (these attacks usually lasted only a few minutes) finally developed weakness, pulse of high tension, vomiting albumin, a few casts in the urine, and frequent epistaxis Death occurred suddenly in collapse

At the necropsy both kidneys appeared normal but there were hemorrhages in the renal pelvis, the mucous membrane of the small intestine, the media and adventitia of the pulmonary artery likewise into the endocardium and superficial muscular layers of the left ventricle Bilateral tumors of the suprarenal glands were found The tumor of the left suprarenal was about the size of the fist while that of the right was the size of a hazelnut The pathological diagnosis was thought to be angiosarcoma of the left suprarenal capsule and sarcoma of the right The description of the latter tumor convinced certain French authors (Azemar and Peyron) that it was undoubtedly a chromaffin cell tumor

Herxheimer mentions a case of Perley 1890, who described a tumor which he called an angiosarcoma of the right suprarenal gland in a man aged 68 years Herxheimer believed that this was probably a chromaffin cell tumor

Berdex, 1892, described a tumor found accidentally at autopsy in a 70 year old man who had died from pneumonia The tumor was 2.5 centimeters by 3.5 centimeters, firm consistency, brown color, and very vascular The mass was ovoid in shape and occupied the principal part of the right suprarenal gland The author believed the tumor arose from the medulla of the gland Zeckwer considered it to be a pheochromocytoma

Manasse, in 1893 described a dark brown tumor which was found accidentally at autopsy in the left suprarenal gland of an "old" woman who had died from tuberculosis Rahin believed that this tumor showed the characteristics of a pheochromocytoma

TABLE III

Author Date	Age Sex	Tumor location and size	Chief points in clinical information	Operative procedures or cause of death	Remarks
Kabata (Nussner and Wendt) 1910	41 M	Right 9-7-6 cm	Abdominal tooth Attacks of severe headache	Tooth extraction under local anesthesia (co- caine 14 per cent)	Patient expired from shock. Necropsy re- vealed pulmonary edema, hypertrophy of the heart. Extract from tumor contained large quan- tities of adrenalin.
Harde 0	6 F	Right 7-4 cm	Myocarditis Arteriosclerosis Diabetes	Amputation of apophysis extremity	Patient expired apparently from shock. Necropsy revealed cystic suprarenal tumor with alveolar arrangement of its cells which showed the specific chemodectoma reaction.
Healy 1913	41 M	Right 6 cm	Heart trouble thought to be nervous in origin. Severe hypertension without evidence of nephritis Hemorrhoids Glycosuria	Hemorrhoidectomy under local anesthesia (sarcocaine)	Patient died following operation. Necropsy Chromaffin tumor hypertrophy of the heart, anemia of lungs.
Orth 1914	41 M	Right Duck egg	B P 120/70 mm. Hg Abdominal cramps at times Enlarged heart	None	Only cause of death revealed at the post- mortem examination was the "para- glyngoma." The tumor contained large amounts of apoplexus.
Mason and Martin 1913	43 F	Right Large kidney	? Tumor of gall bladder 1 frequent attacks of suffocation	Attempt to remove tumor	Only biopsy was obtained. The patient was in violent shock disproportionate to the length of the operation and the quan- tity of blood lost.
Rebel and Wachle 1917	44 M	Bilateral	Hypertension Multiple apoplexus Diabetes and chronic nephritis (Glycosuria and albuminuria)	None	In attempting to explain the symptoms of the patient during 106 on the basis of the complete necropsy findings, these authors regarded it as case of chronic adrenoma pneumonia.
Zachew 1918	44 F	Left 4-3-4 8 cm	Cardiovascular syphilis (Last history not reported)	Died in convulsions	Necropsy Neurofibromatosis of spinal nerves Syphilitic aortitis with pulmonary edema
Overling and Jung 1917	48 F	Left Large kidney	Variable hypertension Pregnancy Violent headaches	Normal delivery	Within 6 hours patient died in shock. The kidney showed no significant pathol- ogy. There was voluminous heart.
Von der Muhl (Rosen) 1918	43 F	Right Orange	Periodic dyspnoea Diabetes with anæmia ? Primary tumor of the liver	Exploratory	Tumor was successfully extirpated. The patient made good recovery and was free from her former attacks.
Wachle and Rebel 1918	41 M	Right Hen's egg	Epileptiform attacks Glycosuria and albuminuria Brown pigmentation of face and arms Mild hypoparathyroidism B P was never taken during an attack Headaches, dyspnoea, and tachycardia	None	Necropsy Hypertrophy of heart. No evidence of nephritis. Authors believed patient's symptoms were due to hyper- adrenarthritis.
Schroeder 1918	41 F	Bilateral Apple	Hypertension Periodic dyspnoea with polyuria, nausea, and fatigue Enlarged heart Glycosuria which would not respond to insulin	Patient died from broncho- pneumonia	Necropsy Generalized arteriosclerosis. Hypertrophy of heart. Scarcely on the suprarenal tumor revealed large quan- tities of adrenalin.
Berter 1919	41 M	Left	Epileptiform convulsions B P 160/110 Enlarged heart Evidence of cerebral lesion	Cerebral hemorrhage	This patient was sent into war line his per- son was too disturbed to permit of reliable answers to questions. Necropsy General arteriosclerosis with cerebral hemorrhage and bronchopneumonia.
Paul 1921	44 M	Right Hen's egg	Periodic attacks of nausea and vomiting with headaches Motor disturbances with short periods of anæmia B P ranged from 83 to 160 mm Hg systolic	? Uremia	Necropsy Hypertrophy of heart Mild kidney damage
Paul 1921	44 M	Right 1st	Periodic attacks of dizziness, headaches, and vomiting Elevated hypertension Was seen on a terminal attack his pupils became dilated and his entire body be- came red	? Atropine poisoning	It was thought the patient possibly had been given medicine by mistake and tentative diagnosis of atropine poisoning was made. A legal postmortem examina- tion with chemical analysis of stomach contents failed to substantiate this theory.
Larsen and Lundberg 1923	47 F	Left	Pain in left flank, dysuria, polyuria, and hematuria	Tumor successfully removed	The patient made an uneventful recovery
Reck 1923	44 F	Left 4-4 cm	Hypertension This patient was seen terminally following cerebral accident	Cerebral hemorrhage	An extract was made from the tumor and proved to contain epinephrine

Robert, 1899, described a case, according to Azemar, in which the patient was a male, aged 46 years, with arterial hypertension and a suprarenal tumor. An attempt to remove the tumor surgically proved fatal to the patient. The description of the pathological findings at autopsy convinced Peyron and Azemar that this was also a case of pheochromic tumor of the suprarenal medulla.

A case mentioned by Neusser and Wiesel was that of Wiesel in 1909. The patient was a 2½ year old child with a chromaffin tumor of the suprarenal gland and advanced arteriosclerosis identically similar to those produced experimentally by the injection of epinephrine.

Bonnamour, Doubrow, and Montague mentioned a case of Graviar and Bernheim which was said to have been malignant.

Connor mentioned that he had seen 2 cases. Ewing stated in his textbook that he had seen a case. Geschickter in a personal communication stated that he had seen sections from a case which showed metastases to bones.

Pheochromic tumors are known to occur in animals. Several interesting pathological studies upon these tumors found in animals have been recently reported.

DEDUCTIONS

Although the incidence of the pheochromocytomata is relatively rare it may be that when the attention of the profession is directed to them their rarity may be more apparent than real. No doubt many of these cases of pheochromocytomata have been diagnosed incorrectly from the histopathological viewpoint. The clinical symptomatology plus the chromaffin reaction are material aids to the pathologist in arriving at the diagnosis. In regard to the chromaffin reaction, the tissues should be fixed in bichromate solution immediately, for the reactions destroyed by other fixing solutions. The quantitative chemical examination of the tumor tissue should be carried out immediately, due to the rapidity with which adrenalin oxidizes.

The close relationship that is known to exist between the suprarenal medulla and the thyroid gland is borne out in the study of these tumors. Many of the patients' symp-

toms were similar to those seen in hyperthyroidism. In fact several cases have been operated upon for goiter while many were shown to have had pathological changes in the thyroid gland at necropsy. That the patients' symptoms, however, were independent of abnormalities in the thyroid gland is shown by numerous cases in which were present the typical syndrome without demonstrable pathological lesions in these glands. Another interesting fact is that the chromaffin tumors do not give rise to the clinical states known as the polyglandular syndrome in which there are somatic changes. There were also no cases presenting a clinical similarity to those recently described by Dr. Harvey Cushing as "pituitary basophilism." The hypertension, glycosuria, weakness, and occasional erythremia were the only similar findings and these, as has already been seen in the case of chromaffin tumors, are a part of a generalized sympatheticotonia. Whether these symptoms, in the cases of basophilic adenoma of the pituitary, are dependent upon an associated activity of the secondary endocrine organs, such as the suprarenal medulla, sympathetic mechanism is a matter of conjecture.

In the study of pheochromic tumors the question of possible hyperchromaffinism in the absence of a tumor of the medullary substance, presented itself. Recently there has been considerable evidence brought forward in favor of this possibility. The similarity of the symptoms-complex of certain cases recently described as "non goiterous hyperthyroidism" to the "suprarenal sympathetic syndrome" here described lends further evidence for speculation as to the etiological factors involved in producing these clinical states. Again there have been certain tumors of the suprarenal cortex described in the literature which have had signs and symptoms unexplained on the basis of the main lesion but could be more logically attributed to the definite hyperplasias of the chromaffin tissue found in those cases.

MECHANISM OF SYNDROME

From the personal case presented and a majority of those cases here reviewed in which

there was sufficient clinical information it is obvious that there is associated with these benign suprarenal pheochromocytoma a definite clinical syndrome. It would appear reasonable that there is a causal relationship between these tumors and the symptomatology presented by the patients in whom they are found. Whatever the cause the symptoms of these patients are undoubtedly produced through the mechanism of the sympathetic nervous system.

The large quantity of epinephrine recovered from the tumor in our case together with the clinical symptoms of the patient during life offers considerable evidence that cannot be discarded lightly in attempting to explain the mechanism by which these tumors produce an excessive stimulation of the sympathetic nerve endings. It is known that epinephrine stimulates the sympathetic nerves and produces a variety of effects dependent upon the function of the several structures supplied by the nerves. In sufficient dosage and under certain experimental conditions this drug has been shown to produce a sudden increase in blood pressure glycosuria tachycardia vasoconstriction followed by vasodilatation of peripheral vessels a sensation of heat fever nausea vomiting exophthalmos diaphoresis, mydriasis nervousness urinary suppression followed by polyuria pulmonary edema, shock and death hemorrhages into the liver lungs kidneys, mucosa of the gastrointestinal tract and the central nervous system hypertrophy of the heart and various vascular lesions.

It can be readily seen that it would be possible to explain all the outstanding signs and symptoms, as well as the postmortem findings of these patients on the basis of the release into the blood stream of excessive quantities of epinephrine.

The contention that these tumors are actively secreting and that the clinical states associated with them are in fact an 'hyperadrenalemia' has been maintained recently by numerous authors. Chemical proof of this is lacking since present methods are not delicate enough to demonstrate chemically an hyperadrenalemia. However it is clear that the syndrome is produced through the mech-

anism of the sympathetic nervous system a system closely related developmentally and functionally to the suprarenal medullary tissue the seat and origin of the pheochromocytomata.

It was due to these facts that we chose to call the clinical states associated with medullary pheochromocytoma the suprarenal sympathetic syndrome in contradistinction to the suprarenal genital syndrome which is associated with certain neoplasms of the cortical portion of these glands.

SUMMARY AND CONCLUSIONS

1. A personal case of pheochromocytoma, the largest tumor of this type yet described in the literature, has been reported.

2. These tumors arise from certain mature adult cells of the suprarenal medulla. These specific cells assume a brown color when treated with chrome salts and for that reason are called chromaffin cells or pheochromocytes. It is these cells which produce adrenalin. The terms used to designate the tumors arising from the pheochromocytes are paraganglioma and pheochromocytoma. The term pheochromocytoma is preferable since it is descriptive of the predominating type of cell.

3. The available clinical facts associated with the pheochromocytomata have been brought together and summarized in detail.

4. A comparison of all the other reported cases of pheochromocytoma in which clinical histories and physical examinations were given showed a striking similarity in symptomatic and pathological data. The typical clinical features of this syndrome are: Hypertension or paroxysmal hypertension, glycosuria, evidences of instability of the sympathetic nervous system such as periodic attacks of sympatheticotonia with tachycardia and vasoconstriction followed by vasodilatation as shown by pallor followed by flushing of the skin, nausea, vomiting, headaches, nervous manifestations with sensations of constriction in the epigastrium, dyspnea, suffocation or choking attended by an increased susceptibility to shock and pulmonary edema.

5. Further analysis of these cases disclosed that the patients were all adults. There was

occurrence in both male and female about equal number. The size of the tumor varied from 3 grams to 100 grams. These tumors were benign and had a tendency to become cystic and undergo necrosis and hemorrhage. When examined chemically they were shown to contain excessive quantities of adrenalin.

6 When surgical removal of the tumor was successful it completely relieved the patient of all signs and symptoms typical of this syndrome.

7 For the association of pheochromocytoma of the suprarenal medulla with clinical evidences of instability of the sympathetic nervous system we have chosen the descriptive term "suprarenal sympathetic syndrome."

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ACUTE OSTEOMYELITIS

A CLINICAL AND EXPERIMENTAL STUDY¹

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EARLY diagnosis and treatment is as important in osteomyelitis as in appendicitis because in the former a policy of watchful waiting often leads to an unnecessarily extensive destruction of bone and sometimes even to loss of life. As the earliest stages of osteomyelitis are understood rather imperfectly we have attempted through a clinicopathological study of early cases, and by means of animal experimentation, to fill in the gaps in our knowledge of this subject.

One of the earliest pictures of acute osteomyelitis was given by Starr who stated "Infection starts in the metaphysis or diaphyseal side of the epiphyseal line, it extends most easily along the epiphyseal line to the cortex and the periosteum, it readily and early strips the periosteum, with increasing tension as more pus is formed, with increased tension the infection probably spreads backward through the haversian canals at various levels and invades the medulla from the cortex giving this spotty character to the shaft infection." A somewhat different view of the development of acute osteomyelitis is advanced by Wilensky who advocates the "mechanistic theory." He regards the necrosis of bone as the result of emboli which lodge in various vessels of the bone causing their thrombosis. He states further "The various pathologic pictures that result depend upon the size of the plugged vessel the relative position of the plug the powers of vascular anastomosis the capabilities for development of collateral circulation in conjunction with the character virulence etc. of bacteria giving rise to the infection. Thus he explains the involvement of an entire bone as the result of the plugging of the main nutrient artery and the necrosis of one half of the bone as caused by a thrombosis of one of the two main branches of the nutrient artery. Smaller areas of infec-

tion are thought to result from the lodgement of bacterial emboli in smaller vessels.

EXPERIMENTS

The study of operative material in acute osteomyelitis gives but a fragmentary view of an inflammatory process which has been going on for several days or even weeks. For this reason we turned to animal experimentation to clarify the earliest pathological changes. Limited space permits only a statement of the method used and a summary of the results obtained.

METHOD

An acute osteomyelitis was produced in 33 rabbits by the insertion of a culture of *Staphylococcus aureus* through a hole drilled in the tibia near its upper end. The development of infection in the bone was followed by the daily recording of the animal's temperature and by weekly X-ray pictures. The animals were killed at various periods from 1 day to 6 months following the operation. It was possible to make microscopic sections of the entire upper half of the tibia and thus to observe all the stages of infection and the defensive processes called forth.

RESULTS

The changes which take place following the experimental introduction of infection into a long bone may be summarized in the following manner:

1 The blood vessels become engorged and the bacteria are walled off by fibrin pus cells, macrophages and fatty tissue forming definite zones in the order named from within outward (A, B, C, D, Fig 1).

2 Newly formed bone (involucrum) which appears after 1 week, comprises the outer shell of the defensive wall and also replaces necrotic bone (E Fig 1).

¹This work has been conducted under a grant from the Christae Breon Fund for Medical Research of the University of California.



Fig. 1. Microscopic section through the wall of an abscess in a rabbit's tibia, 7 days after infection with *Staphylococcus aureus*. *B* fibrin, *B* pus cells, *C* macrophages, *D* fatty tissue, *E*, involucrum.

3 The separation of dead bone (sequestrum) from the living cortex takes place after 2 or 3 weeks by means of a thrombosis of the vessels in the haversian canals which in turn become enlarged and invaded by connective tissue and osteoclastic cells (1 *B C D* Fig 2).

4 The bone marrow is replaced by fibrous tissue containing many fat cells.

5 In the chronic stage the contour of the bone is restored by involucrum and the sequestra float unattached in an abscess cavity (Fig 3).

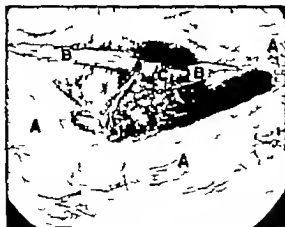


Fig. 3. Microscopic section of rabbit's tibia 31 days after infection with *Staphylococcus aureus*. *A* Involucrum, *B* sequestra, *C* abscess cavity.

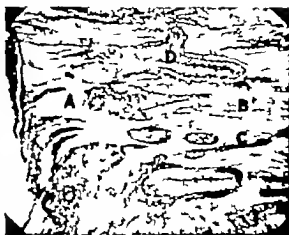


Fig. 4. Microscopic section through the cortex overlying an abscess in a rabbit's tibia, 14 days after infection with *Staphylococcus aureus*. *A* Dead cortex, *B* living cortex, *C* thrombosed haversian canal, *D* an enlarged haversian canal separating the dead from the living cortex.

CLINICAL STUDY

Certain cases of acute osteomyelitis were given rather careful clinical and pathological examinations in the hope that a diagnosis might be made as early as possible and that treatment might rest on a sound basis.

CASE 1. E. G., a girl, 4 years of age, entered the hospital because of pain and swelling over the lower half of the right tibia of 4 days duration. The temperature on entry was 40 degrees C and the white cell count 21,000. At operation, 5 days after the onset of symptoms, a large subperiosteal abscess was found on the medial side of the tibia over its distal half. This abscess was packed open with Dakin's tubes and gauze but the cortex was not opened. A culture of the pus gave a growth of *Staphylococcus aureus*, and on the day after operation, the same organism was found in the blood stream. An X-ray examination made on the seventh day of the disease showed an area of slight rarefaction in the lower end of the right tibia just above the epiphyseal line (Fig. 4). The patient died on the following day at which time there were signs of meningitis. At autopsy the lower fourth of the tibia was removed, and large microscopic sections were made by the celluloid method.

A careful inspection of one of these microscopic sections tells the story of acute osteomyelitis. In Figure 5, the central photograph shows the microscopic section in its approximately normal dimensions and corresponds to the distal one and one half inches of the tibia, a roentgenogram of which comprises Figure 4. Surrounding the central picture are six photographs in various degrees of magnification, corresponding to fields enclosed by the respective dotted rectangles. At *C*, one sees normal cortex

covered with periosteum and lying over marrow which also is free from infection. Nearer the epiphyseal line at A a pus filled haversian canal penetrates the cortex and carries the infection outward from the cancellous bone to the subperiosteal region. The opposite cortex at D shows numerous perforations through which infection has passed with a resultant large subperiosteal abscess and stripping of the periosteum. B pictures a wave of pus surging up the marrow cavity. There is no defensive wall of granulation tissue between the infected and normal marrow.

About two-thirds of the epiphyseal line has been destroyed by the infection, the point of transition between the normal and diseased epiphyseal plate being shown at F. The cartilage of the ankle joint remains intact although the epiphysis is infiltrated with pus cells. In E the oil immersion lens reveals large clumps of staphylococci scattered through the cancellous bone near the epiphyseal line at which point the infection probably first began to develop.

This child evidently succumbed to an overwhelming infection to which little defense was offered. In the absence of early drainage of the medullary cavity the increasing pressure threw many staphylococci into the blood stream and produced an extreme toxemia. This case showed the usual origin of the infection on the shaft side of the epiphyseal line followed by a perforation of the overlying cortex and the production of a subperiosteal abscess.

CASE 2 This resembled the first case in several respects. R. M. a boy 8 years of age was seen 6 days after the onset of pain, swelling and tenderness over the lower half of the left tibia. One week before these symptoms began the patient had received a deep laceration over the left knee which healed with out apparent infection. On entry the patient's temperature was 38.4 degrees C. and his white cell count was 22,000. A blood culture taken on entry showed *Staphylococcus aureus*. Roentgenograms of both tibiae 6 days after the onset of symptoms gave definite evidence (rarefaction of cancellous bone) of an osteomyelitic process just above the distal epiphyseal line of the left tibia.

An incision was made over the lower end of the left tibia opening into a large subperiosteal abscess. When the medullary cavity was drilled into it was found to contain pus under pressure and this was drained by removing a window of cortex 1 1/2 inches long and 3/4 inch wide. A vaseline pack was inserted and a cast was applied.

After an initial fall in temperature a daily swing to between 39 degrees C. and 40 degrees C. persisted for 1 week during which an abscess appeared over the upper end of the tibia. Following the drainage of this abscess, the temperature fell to normal, and the patient improved steadily. Four months later, large sequestra were removed from both ends of the tibia after which the wound filled in rapidly with granulation tissue.

A microscopic examination of the piece of cortex removed at the first operation showed the extension



Fig. 4 Case 1. Roentgenogram of the distal two-thirds of tibia, 7 days after the onset of symptoms.

of an infected thrombus through a large haversian canal. A culture and smear of the pus found at operation showed *Staphylococcus aureus*. Re-examination of the blood 5 days after operation indicated the disappearance of this organism from the blood stream.

CASE 3 E. D. a boy 2 years of age presented a similar picture 1 week after the onset of pain and swelling over the medial aspect of the lower third of the right leg. These symptoms appeared a few days after a sore throat and fever had been observed. When first seen the patient appeared toxic, had a temperature of 39.2 degrees C. and showed a red, dened swelling just above the right internal malleolus. Five days after the onset of symptoms roentgenograms of both legs, for comparison, showed two small areas of rarefaction in the lower end of the right tibia just above the epiphyseal line (Fig. 6). In this illustration a slight rarefaction of the medullary cavity in its distal inch also was detected.

At operation a large subperiosteal abscess was found over the lower third of the tibia. The medullary cavity which contained pus under pressure was drained by a window 1 inch in length by 1/2 inch in width, a vaseline pack was inserted and a cast was applied. The patient's temperature dropped to normal in a few days and he left the hospital after 10 days. Three months later several sequestra were removed after which complete healing of the wound occurred.



Fig. 5. Case 1. Photomicrographs of the distal end of the tibia, 8 days after the onset of symptoms. Peripheral photographs are enlarged views of the corresponding areas enclosed in dotted rectangles in the central photograph. *A*, Cortex crossed by enlarged Haversian canal filled with pus. *B*, marrow at transition from infected to normal areas. *C*, normal cortex and marrow. *D*, thinned cortex, denuded of periosteum, and perforated in several places. *E*, clusters of staphylococci at origin of infection. *F*, epiphyseal line undergoing solution.

CASE 4. W. B., a boy 13 years of age, was seen 9 days after the onset of pain in the right ankle. One month earlier two boils had appeared on the back of his neck and had healed. At entry localized swelling, heat, redness, and tenderness were noted over the lateral aspect of the ankle; the temperature was 38.6 degrees C. and the white cell count 15,000. An X-ray picture taken 10 days after the onset of symptoms showed an osteolytic process involving both the cortex and medulla of the distal 2 inches of the right fibula, with a slight thickening of the overlying periosteum.

Operation at this time revealed an abscess which had lifted the periosteum from the anterolateral aspect of the lower fourth of the fibula. This extent of fibula was saucerized, the wound was packed with vaseline gauze, and a cast was applied. Healing occurred without the formation of sequestra. Microscopic examination of the fragments removed at operation showed dead spicules of bone surrounded by fibrous tissue which was infiltrated with pus cells, macrophages, and giant cells. The inflammation extended to the epiphyseal line of the fibula. A culture of the pus showed *Staphylococcus aureus*.

CASE 5. T. S., a Japanese boy 14 years of age, entered the hospital complaining of pain, swelling, and tenderness over the upper end of the left humerus of 3 days' duration. Eight days prior to entry the patient had had a furuncle over the left knee. The white cell count on entry was 21,000 and the temperature was 38.8 degrees C. A blood culture showed *Staphylococcus aureus*. Roentgenograms of both shoulders were negative except for a slight swelling of the soft parts over the left shoulder.

An operation was performed within 2 hours of entry into the hospital and showed an abscess of reddish brown pus half surrounding the upper third of the left humerus on its anteromedial aspect. When a hole was drilled through the cortex a similar type of pus was found within the medullary cavity. A window 1.5 inches long and $\frac{1}{4}$ inch wide was made through the cortex on the anteromedial surface of the humerus, extending to within 1 inch of the upper epiphyseal line. A vaseline pack was inserted loosely into this window and a spica cast was applied to immobilize the shoulder in abduction. The patient's temperature fell nearly to normal on the third day after operation, showed a secondary rise to 40.8



Fig. 6 Case 3. Roentgenograms of lower ends of both tibiae, 5 days after onset of osteomyelitis of right tibia. There is an area of rarefaction just above the epiphyseal line, and decreased density of cancellous bone at the lower end of the right tibia.

degrees C. on the fifth day gradually fell to normal on the tenth day and showed no further rise above normal. Moderate drainage persisted until 3 months after the primary operation at which time three sequestra were removed and the upper humerus was saucerized. After this the wound healed rapidly.

Microscopic sections of the window of bone removed at the primary operation 2 days after the onset of symptoms (Fig. 7) show an enlargement of haversian canals which provides pathways through the cortex along which the infection passes outward from the medullary cavity to the subperiosteal region. A small abscess is seen to be stripping the periosteum from the cortex. The large number of red blood cells seen in the exudate doubtless accounts for its reddish tinge noted at operation and probably is a characteristic of the earliest stage of osteomyelitis.

CASE 6 A girl aged 13 months entered the hospital because of eczema involving the face and scalp. Ten days later it was noticed that movements of the left shoulder were painful. The temperature rose to 40 degrees C. at this time but gradually declined for 4 days. The temperature then rose again and there was moderate swelling in the region of the left shoulder. The X ray examination of both shoulders 8 days after the onset of symptoms revealed a clear cut area of rarefaction in the upper end of the shaft of the left humerus extending up to but not across, the epiphyseal line (Fig. 8).



Fig. 7 Case 5. Photomicrograph of the upper end of the humerus, 2 days after the onset of osteomyelitis. Medium magnification. P Periosteum stripped from cortex C by abscess A H Haversian canal through which infection passes outward from medullary cavity M

An operation was performed on the following day, through an anterolateral incision. No periosteal thickening or abscess was encountered. A drill inserted through the cortex, encountered a cavity, and a thick purulent fluid flowed out of the drill hole. This cavity was exposed fully by the removal of a window of cortex 1 inch long and one-fourth inch wide. A vaseline pack was inserted but no cast was applied. The wound healed completely in 3 weeks, without the formation of sequestra. A culture from the pus encountered at operation gave a growth of *Streptococcus hemolyticus* beta.

REVIEW OF CASES

From a review of this series of six clinical cases, certain facts become evident. In all cases but 1, there was a history of infection of the skin or of a sore throat from 1 week to 1 month before the onset of the symptoms of osteomyelitis. Osteomyelitis usually begins in the shaft of a long bone, close to an epiphyseal line. The infection soon spreads outward through the haversian canals of the cortex to form a subperiosteal abscess. This abscess rapidly increases in size and lifts the periosteum from a large area of bone. Clinical signs of acute osteomyelitis become more obvious with the development of the subperiosteal abscess.



Fig. 8 Case 6. Roentgenogram of the left humerus 8 days after the onset of osteomyelitis at its upper end. An abscess cavity is seen extending up to the epiphyseal line.

X ray evidence of an osteomyelitic focus may be obtained as early as 5 days after the onset of symptoms, provided a roentgenogram of the normal extremity is taken for comparison. One should look for an area of rarefaction in the shaft close to the epiphyseal line. This is contrary to the usual teaching that the X ray has no value in the diagnosis of acute osteomyelitis. On the other hand one should not delay operation because the X ray examination is negative.

A blood culture taken during the acute stage of osteomyelitis will be positive for *Staphylococcus aureus* in a large proportion of cases. In fact the infection in the bone must result from the presence of such organisms in the blood. Blood cultures taken a few days after drainage of the osteomyelitic cavity usually are negative.

TREATMENT

In acute osteomyelitis widely varying operative procedures have been advocated ranging from the opening of the periosteum only in severe cases (Ochsner and Crile) to the radical excision of a large extent of the shaft (Le Conte). Starr drilled several holes through the cortex close to the epiphyseal line. It is Robertson's practice to follow this drilling with the removal of a small window of cortex to expose the abscess when one is found. A similar procedure is advocated by Bancroft on the basis of animal experimentation as he concluded that cortex which is apparently

dead may serve as the framework for a new shaft. Bancroft prefers postoperative dakinization of the wound.

A notable contribution to the treatment of osteomyelitis was made by Orr as a result of his experience in the World War. He secures adequate drainage by means of a window which completely exposes the infected portion of the medullary cavity and the wound is held open by a vaseline pack. The application of a plaster cast immobilizes the limb in good position thus resting the diseased part and preventing contamination of the wound. The entire dressing is changed with aseptic technique when the odor becomes marked or a rise in temperature occurs. The results obtained by the use of the foregoing method in the hands of many surgeons have proven to be very satisfactory.

CONCLUSIONS

1. Osteomyelitis is an infection caused by *Staphylococcus aureus* which travels through the blood stream and localizes at the end of a long bone.

2. Early symptoms are pain, swelling, local heat, tenderness, a high fever and a high white cell count.

3. Within 5 to 7 days of the onset of symptoms the X ray may show a rarefaction of the cancellous bone near the epiphyseal line which is apparent when compared with a film of the opposite side.

4. An operation should be performed as soon as a diagnosis of probable osteomyelitis is made and should consist of drainage of the medullary cavity by means of a window removed from the cortex. The use of a vaseline pack and cast as advocated by Orr has proved very satisfactory although good results are obtained by Dakin's irrigations or by the use of other frequently changed dressings.

5. In some cases a considerable portion of the shaft will separate as sequestra and will be surrounded by newly formed bone (involucrum). The removal of sequestra should be attempted only when sufficient involucrum has formed to maintain the continuity of the bone, usually 2 or 3 months after the primary operation.

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THE SINGLE PYOGENIC LIVER ABSCESS

A STUDY OF TWENTY FOUR CASES¹

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THIS report is based upon the study of 24 cases of single pyogenic liver abscess which have come to operation since 1915. The purpose of this study is to emphasize the fact that the single pyogenic liver abscess is a definite recognizable, clinical entity with a hopeful prognosis following surgical intervention.

INCIDENCE

It is not possible to give an estimate as to how frequently this condition occurs since there are probably many liver abscesses which never come either to operation or to autopsy and the diagnosis is therefore often missed. Of our 24 cases 17 were in males and 7 in females or a ratio of 2.5 to 1. Pyogenic liver abscess is most commonly seen in young or middle aged adults 8 of the 24 patients or one third the total number were between the ages of 40 and 50 years. The youngest patient was 15 years old the oldest was 65 years of age. Table I shows the age incidence.

TABLE I — AGE INCIDENCE

Age in years	Cases	Percentage
to 10	0	00.0
10 to 20	1	4.2
20 to 30	5	20.8
30 to 40	3	12.5
40 to 50	8	33.3
50 to 60	6	25.0
60 to 70	1	4.2

BACTERIOLOGY

Elsberg and Giordano found sterile pus in about 60 per cent of their cases. The pus from 11 of 24 cases in this group was sterile a

percentage of 45.8. Of the 13 cases in which organisms were found 3 showed *Staphylococcus aureus*, 2 were *Staphylococcus albus*, 2 were streptococci, 2 were *Bacillus mucosus capsulatus*, 2 were unidentified gram positive bacilli, 1 was *Bacillus coli* and 1 was *Bacillus pyocyaneus*. Elhason in reporting 12 cases of liver abscess also found the staphylococci streptococci *Bacillus mucosus capsulatus* and *Bacillus coli* to be the invading organisms. Alessandrini states that the principal organisms found are the staphylococci streptococci colon bacillus typhoid bacillus pneumococci and *Bacillus pyocyaneus*. In this series there are no instances of two organisms being present in 1 case but the 2 cases which showed gram positive bacilli may be examples of an anaerobic organism accompanying some other bacterial invader. No amoebae or parasites were found either in the abscess cavities or in the stools of any of the cases.

Table II shows how frequently each organism was found and also the number of patients who recovered. It is striking to note that most of the deaths (8 of 10) occurred in those cases from which no organism could be found.

TABLE II — INCIDENCE

Organism	Cases	Recovered	Died
Sterile	11	5	6
Staphylococci	3	4	1
Streptococci	2	2	1
Bacillus mucosus capsulatus	2	2	0
Gram-positive bacilli	1	1	0
Bacillus coli	1	1	0
Bacillus pyocyaneus	1	1	0

TABLE III—MULTIPLE LIVER ABSCESS

Case	Etiological factor	Interval between original disease and liver abscess
Case 1	Acute suppurative appendicitis	1 week
Case 2	Acute suppurative appendicitis	2 weeks
Case 3	Gangrenous cholecystitis	1 week
Case 4	Humerohydrothorax	1 week
Case 5	Perforated duodenal ulcer	1 week
Case 6	Acute cystitis of gall bladder	1 week
Case 7	Acute suppurative appendicitis	1 week
Case 8	Gangrenous cholecystitis	1 week
Case 9	Gangrenous cholecystitis	1 week
Case 10	Pyelitis, cystitis, vaginitis	1 week
Case 11	Chronic ulcerative colitis	1 week
Case 12	Humerohydrothorax	1 week
Case 13	Portal vein thrombosis	1 week
Case 14	History not determined	

Blood cultures were taken in 14 of the 24 cases and all proved to be negative. This is in keeping with results obtained by most investigators.

PATHOGENESIS AND PATHOLOGY

The term single pyogenic liver abscess is perhaps not entirely accurate since the original pathological process frequently consists of many small abscesses closely clustered in one area which eventually conglomerate to form one large abscess, often multiloculated. According to Alessandri and others, the abscess occurs about five times more frequently in the right than in the left lobe and usually points to the dome of the liver. All the abscesses in this series were in the right lobe, 18 of them pointing to the dome. Four localized in the lower part of the right lobe, one was located in the middle anterior part of the right lobe and one other was on the inferior surface. Concerning the reason for the great predominance of right over left lobe abscess, we refer the reader to the theories of S  r  ge Dominici and others.

There are thought to be at least six routes by which bacteria or emboli may reach the liver and thus give rise to abscess formation. These are by way of the portal vein, by way of the hepatic artery, through the bile ducts by direct extension, by way of the hepatic veins and through the lymph stream. Most authors think that infected emboli which are carried into the portal vein from foci of infection located in the appendix, stomach, duodenum, intestines, anal region and pelvic organs are the commonest cause of liver abscess. Eliason has expressed the belief that suppuration of the appendix is the cause of

TABLE IV—SINGLE LIVER ABSCESS

Case	Possible etiological factor	Interval between original disease or possible etiological factor and liver abscess
Case 1	Acute suppurative appendicitis	26 weeks and 9 weeks
Case 2	La grippe	1 week
Case 3	Acute sinusitis	1 week
Case 4	Necrobacillary pneumonia	4 weeks
Case 5	La grippe	1 week
Case 6	La grippe	1 week
Case 7	La grippe	1 week
Case 8	La grippe	1 week
Case 9	Vague gastric symptoms	20 years
Case 10	La grippe	1 week
Case 11	Scabies	1 week
Case 12	La grippe	1 week
Case 13	Salivary glanditis	1 week
Case 14	La grippe	1 week
Case 15	Necrobacillary pneumonia	1 week
Case 16	Vague gastric symptoms	4 years
Case 17	La grippe	1 week
Case 18	Perforated peptic ulcer	1 week
Case 19	La grippe	1 week
Case 20	La grippe	1 week
Case 21	Acute cholecystitis	1 week
Case 22	La grippe	1 week
Case 23	Necrobacillary pneumonia	1 week

nearly 50 per cent of all liver abscesses. Bartle claims that the outstanding cause is thrombosis of the intrahepatic portal vein as a result of focal infection or infection in the gastrointestinal viscera or pelvic and anal regions. Eliason also claims that when the hepatic artery is the portal of entry the abscesses are small, multiple and diffuse. Beaver states that abscesses formed by bacteria which are carried into the liver via the hepatic artery are almost never found except when part of a general pyemic process. There is a rather general agreement in the literature that liver abscess as a result of infection through the lymph stream does not or rarely takes place. Reinger and Kaufmann state that occasionally infected emboli from some focus in the head or neck will reach the liver by a process of retrograde embolism. The embolus arises from some vein in the head or neck and travels via the superior vena cava to the right auricle of the heart, then to the inferior vena cava, and finally to the liver by way of the hepatic veins. Some liver abscesses undoubtedly do occur by direct extension from external wounds penetrating into liver substance and some are definitely the result of infection in the gall bladder with extension of the process through the bile ducts into the liver.

The foregoing writers rarely make distinction between the mode of origin and cause of multiple abscesses of the liver and so called single or "primary" pyogenic liver abscess.

Scrutiny of the cases of single abscess in this series shows that the mode of origin or the etiological factor is known with a fair degree of certainty in only 3 of the 24 cases, whereas the etiological factor in a series of 14 cases of multiple liver abscess¹ (which came to autopsy or were operated upon) can be pointed out with certainty in 13 cases. Tables III and IV show the two groups, i. e., multiple abscess and single abscess, and their etiological factors.

It is seen in Table III that 3 cases of multiple abscess of the liver were preceded by acute suppurative appendicitis with appendectomy, 4 cases were preceded by acute cholecystitis with cholecystectomy, 2 cases were preceded by hemorrhoidectomy. In one patient a perforated duodenal abscess due to a foreign body was found at operation. One patient had chronic ulcerative colitis for 7 weeks preceding symptoms of liver abscess. Two patients showed definite portal vein thrombosis and infection at autopsy but the origin of the thrombosis and infection was not determined. In 1 case no clue was given as to the etiology. It is clear that the portal of entry in 9 of the 14 cases of multiple abscess was through the portal vein, and in 4 cases by way of the bile ducts. In only 1 case was the mode of origin unknown.

Nine of the 24 patients with single liver abscess (Table IV) definitely gave a history of a preceding focal infection. Three of the 9 patients had a nasopharyngitis, 1 suffered from an acute sinusitis, and another had an acute tonsillitis, all within a period of 1 to 4 weeks before the onset of liver abscess symptoms. Three other patients gave a history of so called *la grippe* shortly before the onset of present illness, and another suffered from "sciatica" 13 weeks prior to onset of symptoms. It is important to state that no history of a focal infection or upper respiratory disease was obtained in any of the 14 cases of multiple liver abscess. In 11 cases of single abscess, no possible etiological factor could be determined. There were only 2 cases of single abscess in which the mode of origin was definitely known and in which the etiology could be unquestionably traced to portal vein or bile

duct infection. In Case 19 (Table IV) patient had suffered from a perforated peptic ulcer 3 weeks preceding formation of the liver abscess, and in Case 22 (Table IV) cholecystectomy for acute cholecystitis had been performed 5 months previous to formation of the liver abscess. In Case 1 (Table IV) appendectomy had been done for acute suppurative appendicitis 6 months previously and patient had remained in good health following an uneventful recovery until 9 weeks before development of the liver abscess symptoms when he had been confined to bed with an attack of so called "la grippe". Two other patients (Cases 9 and 16, Table IV) had suffered from vague gastric symptoms for 4 years and 20 years preceding the onset of the present illness, but there was no history in either case of exacerbation of the gastric conditions at any recent date prior to the onset of the liver abscess syndrome.

From the foregoing analysis we see that 19 of the 24 cases of single abscess show no proof of infection by way of the portal vein or bile ducts. In 1 patient (Case 22) the infection arose through the bile ducts and in one other (Case 19) or possibly two (Case 1) the infection arose through the portal vein. In the 2 cases with vague gastric symptoms the infection was of doubtful origin but the possibility of portal infection must be considered.

There is no reason to believe that the single liver abscess arises most frequently through portal vein or bile duct infection when proof of such a contention is entirely lacking in 19 of our 24 cases! To the contrary, it seems more likely that most of these single abscesses arose through hematogenous infection via the hepatic artery. This contention is strengthened by the fact that 9 of our 24 cases gave a definite history of a preceding focal infection.

Elsberg tended to support our view that the single abscess is infrequently of portal origin when he stated that single abscess is rare following appendicitis. Barr states that he has seen this type (single) of liver abscess occasionally follow septic sore throat, otitis media, osteomyelitis and mastoiditis. Sussu reports a case of single pyogenic liver abscess following soon after a furuncle of the back of the neck. He was able to isolate the same organism (*Staphylococcus albus*) from the blood stream

¹Unpublished data from Medical and Surgical Services of Jewish Hospital of Brooklyn.

and the liver abscess. His patient made an uneventful recovery following drainage of the abscess. Lepelnie claims that infection may arise via the hepatic arteries due to suppurative processes in other internal viscera or in the skin. Beaver however is of the opinion that the organisms producing the single liver abscess gain access to the liver through the portal vein. In reporting 8 cases of granulomatous abscess of pyogenic origin he admits that the etiological factor or origin is uncertain and questionable in 7 yet he comes to the conclusion that all arose through the portal vein. All of his cases came to autopsy and although it was felt that the abscesses originated via the portal vein, pyelophlebitis or portal vein thrombosis was found in only 1 case.

To summarize. The single liver abscess cases are most often of unknown or doubtful etiology usually are without proof of portal vein origin and infrequently show pyelophlebitis or portal vein thrombosis. The multiple liver abscesses are of known etiology arise through the portal vein or bile ducts, and usually show pyelophlebitis or portal vein thrombosis.

The pathogenesis of the single pyogenic liver abscess strongly resembles that of carbuncle of the kidney and osteomyelitis. Focal infections such as a furuncle of the skin sinusitis, otitis media, nasopharyngitis and other upper respiratory conditions have long been designated as the source of hematogenous infection leading to the formation of osteomyelitis or carbuncle of the kidney. By the same token the focal infections present in the 9 cases of single liver abscess herein reported might have been the sources of hematogenous infection leading to the development of the abscesses. The significance of a preceding focal infection can not be stressed too strongly!

SYMPTOMS AND SIGNS

Most of our patients on admission to the hospital gave a history of having been sick for approximately 2 to 4 weeks with fever and occasional chills. Loss of weight and strength within a very short time were almost constant complaints. At the onset, only a few of the patients suffered from abdominal pain or presented other symptoms referable to an intra abdominal lesion. Despite the extreme

malaise and asthenia which accompanied the early part of the syndrome many of the patients spent some of the first few days of the illness out of bed only to return when fever or chills recurred. Pain somewhere in the lower right thoracic region was frequently the first symptom to draw attention to the location of the pathological process. This symptom occurred usually within 1 to 3 weeks from the onset of the illness, although in about 20 per cent of our cases it was the first definite symptom of the entire syndrome. The indefinite nature of the patient's complaints and the failure of localizing signs to appear makes it extremely difficult to venture any diagnosis during the first week or two of the disease unless one is thoroughly acquainted with the symptom complex. Three patients had an onset resembling that seen in amoebic abscess. Of these 3 patients, 2 were sick for 3 months and 1 was sick for 6 months before admission to the hospital. Table V shows the duration of symptoms prior to hospitalization.

TABLE V—DURATION OF SYMPTOMS PRIOR TO HOSPITALIZATION

Cases	Duration of symptoms before admission
1	week or less
2	1 week
4	2 weeks
	3 weeks
	4 weeks
	5 weeks
	6 weeks
	1 month
	2 months

Only 3 of the 24 patients were hospitalized within a week of the development of symptoms, thus leading to the conclusion that most of the patients originally gave the impression of not being in need of immediate surgical attention. Sixteen of the 24 patients were hospitalized within 3 weeks from the onset of symptoms.

Seventeen of the 24 patients definitely looked weak and toxic on admission and were listed as seriously sick. Only 2 patients appeared healthy. Malaise was almost constantly present. The majority of the patients had a muddy subicteric complexion, which has often been referred to in the literature as being of hepatic origin. The sclerae in almost all cases were a muddy tan color. Well developed jaundice was present in only 2 patients.

Both of the jaundiced patients had exceptionally large abscesses which extended well down on to the anterior surface of the liver and most probably produced pressure on the bile ducts. From the data in this series it would seem that jaundice is infrequent and occurs only when the abscess exerts direct pressure on one of the larger bile radicals.

Fever was present in every one of the cases reported, and was invariably one of the first symptoms noticed. The average temperature range was from 99 or 100 degrees F to 103 or 104 degrees F and only occasionally rose to a higher level. The temperature was usually higher at the onset of the disease. Fourteen temperature charts showed the remittent type of fever and 10 showed the intermittent type. The pulse rate was in proportion to the temperature with the exception of a few cases in which there was a relatively slow pulse rate. The fever was accompanied by chills in 16 or two-thirds, of the cases and 3 patients had definite chilly sensations with temperature rises. Sweating was found as a common occurrence after a chill. Periodicity of chills, or daily chills were infrequently seen in cases of single abscess but were quite commonly encountered in the patients with multiple abscesses.

Pain in the hepatic area was almost a constant complaint being absent in only 1 case. In 19 of 23 patients, or about 82 per cent the pain was located anteriorly or laterally in the axillary line over some area from the level of the fifth rib down to the edge of the liver. Lumbar pain was present also in 3 of these 19 patients. In the 4 remaining cases the patients suffered only from lumbar or loin pain located over the hepatic region posteriorly. Localized intercostal pain, as Elhason, Alesandri, and others have pointed out is often an important sign in liver abscess and should be looked for in every case in which the diagnosis is suspected. The pain in our cases was usually dull and aching in character occasionally patients were encountered who had sharp, severe pain, and in several cases there was epigastric pain and distress prior to localization of the pain to the liver region. Dull pain was noted to be present more often than sharp pain. Seven patients suffered from

epigastric pain but in 5 of these it was transitory and disappeared when localization occurred. The pain tended to be constant, without relationship to food intake, and without much tendency toward colic or marked changes in intensity. Nine of 23 patients, or 39 per cent, complained of aggravation of pain on inspiration. Many writers (5) report radiations of pain to the right scapular region, left scapular region, right lower quadrant of the abdomen, and to the neck. None of our patients complained of left scapular pain, of right lower quadrant pain, or of neck pain. Two patients did complain of right scapular pain and at operation one of them had an abscess which had ruptured into the subphrenic space, and in the other patient definite diaphragmatic involvement was evidenced on X-ray examination by fixation of the diaphragm and thickening of the diaphragmatic pleura. Since most of the abscesses come to the surface retroperitoneally on the dome of the liver, we see little reason why there should be radiation of pain, except when there is extension of the suppurative process to the peritoneum or pleura. The following outline summarizes our conception of the pain as it exists in liver abscess.

Location

- 1 Over liver area, anteriorly or in axillary line in 82 per cent of the cases
- 2 Loin pain in 20 per cent of the cases
- 3 Intercostal pain frequent

Type

- 1 Usually constant.
- 2 No relation to food intake
- 3 Dull pain more frequent than sharp pain
- 4 Pain on inspiration in 39 per cent of the cases

Radiation

Infrequent

Tenderness over the liver area was found to a variable degree in all of the cases. If an enlarged liver was palpable below the costal margin it was usually found to be quite tender. An important and significant finding was in intercostal tenderness brought about by deep palpation with one finger. It was rarely necessary to use heavy percussion with the closed fist in order to elicit tenderness.

All but 2 of the patients complained of loss of appetite. Rapid loss of weight and strength were the usual observations. Nine of our 24 patients lost over 15 pounds in weight each. 6 patients lost between 5 and 15 pounds each. 3 patients thought they had lost some weight and the 6 remaining patients did not know if there had been any weight loss.

Nausea and vomiting have not been found to be part of the liver abscess symptomatology. Only 3 of our patients complained of nausea and vomiting. This is particularly significant since there are so few conditions of a surgical nature in which one finds chills, fever, pain in the right upper quadrant of the abdomen and other signs of a surgical lesion and yet obtains no history of nausea or vomiting. The importance of the absence of nausea and vomiting as a helpful diagnostic lead will be discussed later. Neither diarrhea nor constipation occurred with any frequency. None of our cases gave history of prolonged diarrhea.

As mentioned before, over one third of the patients complained of pain on inspiration in the right lower chest and right hypochondrium. This is most likely due either to irritation or possibly to the added drag of an enlarged liver on the pleura. Mild shortness of breath and an increased respiratory rate were found in 12 of the 24 patients. This dyspnea was mild, the respiratory rate ranging from 26 to 34 per minute except for 2 cases who experienced marked difficulty in breathing. The marked dyspnea in 1 case was probably caused by a large pleural effusion on the right side. Coughing was present in 14 cases and was usually hacking, non-productive in character. This is referred to by Alessandri as the 'hepatic cough'.

A very important clinical sign was an enlarged liver. The liver was palpable below the costal margin in 17 of 23 or in 74 per cent of the cases. In 8 of these 17 cases enlargement of the liver in an upward direction was also elicited. Enlargement of the liver upward was found in 4 cases where no enlargement was palpable below the costal margin. Three cases presented fluctuant masses in the right upper abdominal quadrant. There were only 2 patients who demonstrated no hepatic enlargement!

Some degree of spasticity of the rectus muscle in the right upper quadrant was noted in about 60 per cent or in 13 of 22 patients. The spasticity however was rarely very marked and only approached real involuntary rigidity in a few cases. Abdominal examination for spasticity was negative in 9 of the 22 cases.

Street and Eliason refer to edema of the right lateral chest wall as an important finding in liver abscess. We have not noted this sign in our cases. Manson Bahr in reporting 40 cases of amoebic liver abscess found edema of the chest wall in only 4 cases.

Pulmonary signs located for the most part over the right lower chest, were seen in many of the cases. Limited expansion of the right chest was found in 7 patients. 11 patients had no limitation of expansion and in the 6 remaining cases no statement as to this sign could be found in the histories. An enlarged and tender liver associated with diaphragmatic and pleuritic irritation most probably produced this limitation of motion. This contention is supported by the X-ray findings. X-ray and fluoroscopy were done in 5 of the 7 patients who had limitation of expansion of the chest, and in 4 out of these 5 patients a fixed and elevated diaphragm was found. Impaired resonance, dullness over the right lower chest was noted in 13 of 22 or approximately 60 per cent of the cases. Many authors claim this to be due to compression of the right lung by the enlarged liver and raised diaphragm. Rales at the right base were a common finding, being present in 68 per cent of our cases. Five of our cases demonstrated pleural effusion in the right chest, but in only 1 case did it attain large enough proportions to necessitate aspiration. One patient developed an empyema of the right chest. The breath and voice sounds were recorded as vesicular in all cases but occasionally were somewhat exaggerated or diminished. Signs of consolidation were absent in all cases.

Roentgenological and fluoroscopic examination was performed in 17 cases. Seven of the 17 examinations revealed elevation and fixation of the right side of the diaphragm suggesting a subdiaphragmatic lesion. The 10 other examinations were negative for any subdiaphragmatic lesion.

A palpably enlarged spleen was detected in only 2 cases. The enlargement of the spleen in these 2 cases may be explained by the fact that both of these patients were sick longer than 3 months before admission to the hospital.

No evidence of ascites was found in any of our patients.

Leucocytosis was found in all but one of our patients. The average number of white blood cells per cubic millimeter was 16,000, the average polymorphonuclear leucocyte percentage was 86. These averages seem to be quite typical of the individual counts in liver abscess cases as shown by the fact that 14 patients had a count somewhere between 12,000 and 18,000, and 16 patients had a polymorphonuclear count between 80 and 86 per cent. The leucocytosis exceeded 20,000 white blood cells per cubic millimeter in only 5 cases and the polymorphonuclear count reached 90 per cent in only 4 cases.

There were no characteristic findings in the urine. Bile was present in the urine of those patients who had definite jaundice.

DIAGNOSIS

The diagnosis of single pyogenic liver abscess was made in the majority of our cases after a careful consideration of the general appearance, symptoms, and signs, and after close observation of the patient over a period of a few days. The difficulty experienced in making the correct diagnosis on first examination can be judged by the initial diagnoses made on the 24 cases in this series. Only 7 patients were admitted with the diagnosis of liver abscess. Six patients were thought to have lesions of the right kidney, in 3 of these the initial diagnosis was haematogenous infection of the right kidney, in 2 patients the diagnosis of perinephritic abscess was made, and the other patient was thought to have a pyelonephritis. Three patients were judged to have subphrenic collections of pus. The first impressions in the 8 other cases were carcinoma of the stomach, duodenal ulcer with localized peritonitis, appendicitis, cholecystitis, typhoid fever, tertiary syphilis, "acute abdomen" of unknown origin, and in one case no diagnosis was ventured on admission. It is interesting

to note, however, that after several days of observation a final pre-operative diagnosis of liver abscess was arrived at in 16 of the 24, or in 66.6 per cent of the patients.

Most of our cases of single abscess were characterized by the lack of a significant antecedent history, although we feel that if a more careful search had been made in every case, many more histories might have included the presence of some previous focus of infection.

Fever, chills, and localized pain in the liver region associated with enlargement and tenderness of the liver and slight or moderate spasticity of the right rectus muscle constituted a syndrome which led to the diagnosis of an acute inflammatory lesion of the liver. The peculiar type of non radiating, constant, dull, or occasionally sharp pain located intercostally or elsewhere directly over liver substance has seldom been seen by us in other conditions. An important aid to diagnosis is the absence of nausea and vomiting. With cholecystitis, pancreatitis, intestinal obstruction, ruptured ulcer, and other conditions accompanied by intraperitoneal irritation, one usually notes nausea and vomiting as a definite part of the syndrome, whereas in liver abscess where there is usually very little peritoneal irritation, nausea and vomiting occur infrequently. X ray findings of an elevated and fixed right diaphragm were found in approximately one-third of our cases and aided greatly in determining the location of the pathological process. The use of thorium dioxide sol in diagnosing liver abscess, as pointed out by Yater and Otell, Reeves and Apple, and others, has proved helpful to some investigators, but can not yet be tried as a routine procedure.

From a point of view of prognosis and treatment it is extremely important to make a differential diagnosis between single pyogenic liver abscess and multiple liver abscess particularly since the former responds much better than the latter to surgical treatment. It has been our experience that this differentiation can best be made by study of the history, by noting the presence or absence of some definite source of infection, and by determining the route which the infective source traveled to reach the liver. If the patient gives a his-

tory of a previous infection such as cholecystitis, appendicitis, hemorrhoids etc. (as in 13 of 14 of our cases of multiple abscess) then the infection reaches the liver via the portal vein or bile ducts and most probably results in multiple and diffuse abscesses. If however no history of a previous abdominal disease is obtained (as in 21 of 24 of our cases of single abscess) then one must suspect a single liver abscess and a hematogenous (via the hepatic artery) source of infection should be sought.

From examination of the patient it was frequently impossible to distinguish single from multiple liver abscess. However in the multiple abscess cases we noted greater and more frequent fluctuations in temperature many times from subnormal to 107 degrees F along with daily chills. Jaundice was encountered more often in the cases of multiple abscess. Palpable enlargement of the liver and spasticity in the right upper quadrant of the abdomen were found in a greater percentage of the patients with multiple abscess than in those with single abscess.

The amoebic abscess is distinguishable from the pyogenic abscess by a history of a previous dysentery by the presence of the *Entamoeba histolytica* in the stool and by differences in the two clinical pictures. The amoebic abscess characteristically has an insidious onset, over a period of many weeks, months, or years, which is usually devoid of very marked temperature rises or chills. Manson Bahr found a history of dysentery or diarrhea in 36 of 40 cases, and recovered the *Entamoeba histolytica* from the stools of 57 per cent of these cases. Many patients with amoebic abscess are entirely free of symptoms, whereas pain and tenderness of the liver are almost always found in cases of pyogenic abscess.

The 3 cases in this series which were at first diagnosed as subphrenic abscess, all proved to have liver abscesses pointing to the right dome, all suffered pain on inspiration and 2 of them were free of chills or chilly sensations. Pain caused by subphrenic abscess is usually more severe than in liver abscess frequently radiates to the scapular region and is almost invariably greatly aggravated by deep respirations. Chills are less frequently found in this

condition and the temperature range is not as great. Jaundice is rare in uncomplicated subdiaphragmatic abscess. A history of a previous abdominal condition such as appendicitis, cholecystitis perforated ulcer and other intraperitoneal suppurative lesions is almost always obtained in cases of subphrenic abscess except when the purulent collection is due to a ruptured liver abscess. Such a history as pointed out previously was unusual in our patients with single liver abscess. The failure to find an enlarged and tender liver along with positive X ray findings for a collection beneath the diaphragm is often sufficient to allow differential diagnosis between subphrenic abscess and liver abscess.

Gall bladder disease since it is many times associated with fever chills pain spasticity in the right upper quadrant of the abdomen and jaundice had to be ruled out. By securing a detailed history and by careful examination of the patient a differential diagnosis was made. History of previous attacks of gall-bladder disease was of great moment since, as mentioned before the single liver abscess was rarely preceded by cholecystitis. Furthermore, the rapid loss of weight and marked emaciation seen so often in liver abscess are unusual in cases of gall bladder disease. Nausea, vomiting, pyrosis, belching and aversion to fatty foods, which are typical prodromal symptoms in gall-bladder disease, were seldom encountered in our cases of liver abscess. The differences in the location and type of tenderness and pain in the two conditions are also invaluable to the establishment of the correct diagnosis. Liver abscess pain tended to be localized directly over liver substance, most often intercostally in the axilla or anteriorly was constant in character dull or occasionally sharp but rarely unbearable, and infrequently radiated. Pain caused by gall bladder disease tends to be located over the region of the gall bladder anteriorly is intermittent, colic like often excruciating and unbearable and frequently radiates. Finally in acute cholecystitis, which is the type most often confused with liver abscess one can usually palpate an enlarged and tender gall bladder.

It can be seen from the initial diagnoses in our cases that difficulty was experienced in

differentiating liver abscess from suppurative lesions of the right kidney. This can be readily understood when one realizes that in 5 of the 6 cases in which the diagnosis was kidney disease the patients complained of loin pain and in 3 of these 6, the loin pain was the only pain suffered. Furthermore, although there was liver enlargement in all of the 6 patients the liver was readily palpable below the costal margin in only 3 patients. When the abscess involves the lower portion of the liver the condition is most likely to be confused with kidney disease as evidenced by the fact that in 3 of the 6 cases the patients were later proved to have abscesses pointing to the lower part of the right lobe of the liver.

The onset of the liver abscess syndrome with chills, fever, pain in the right lower chest, occasionally accompanied by dyspnea, cough and rales at the right base sometimes leads to the initial diagnosis of an early pneumonia. However, the failure of additional pulmonary signs of consolidation to appear, along with the later development of an enlarged and tender liver, spasticity of the rectus muscle, and repetition of the chills, leads one away from this original impression.

Obscure cases may on rare occasions be diagnosed as gumma of the liver, typhoid fever, or malaria but these diseases can usually be ruled out by such specific tests as the Wassermann and Widal reactions or examination of the blood for the malarial parasite.

TREATMENT AND RESULTS

The treatment of single pyogenic liver abscess is always surgical. The type of operation to be done depends upon signs of localization of the abscess. If a mass is found in the right upper quadrant of the abdomen or if it can be proved that an abscess is pointing on the anterior or inferior surfaces of the liver, it is wise to operate through a high right rectus incision. However, if there are no signs of localization of the abscess to the anterior abdominal region then it is advisable to use a transpleural diaphragmatic approach, particularly since the great majority (18 of 24 cases in this series) of abscesses point to the dome of the liver. When there is doubt as to localization it would seem best to explore through a

transpleural diaphragmatic incision with rib resection because this procedure can be carried out retroperitoneally and thus reduce the chances of soiling the peritoneal cavity with the contents of the abscess.

Of the 24 cases, 12 patients were operated upon by the transpleural diaphragmatic two stage method. Sixteen of the 24 patients were operated upon by Linder, and of the 16, there were 10 operated upon by the transpleural method. The 6 other patients had right rectus incisions performed because it was felt that the abscesses were localizing either to the anterior or inferior surface of the liver.

There were 14 recoveries in this group of 24 patients, or a cure rate of 58.3 per cent. Eliaison reports 54 per cent as the rate of cures in liver abscess. Linder, in operating upon 16 of the patients included in this report, had 10 recoveries, a 62.5 per cent cure rate.

The prognosis depends on many factors such as the general condition and resistance of the patient at the time of operation, the type and the virulence of the invading organism, the size of the abscess, the postoperative reaction etc. Other things being equal, it would seem that the location of the abscess within the liver and the type of operation which can be performed, exert a very great influence on the ultimate outcome of the disease. Our results show that 12 of the 18 patients, or two-thirds of those with abscess localizing to the dome of the liver recovered whereas only 2 of 6, one third, of those patients with abscess of the anterior or inferior surface, recovered. Also 9 of the 12, or 75 per cent, of the patients operated upon by the transpleural diaphragmatic method recovered, whereas only 5 of the 12, or 41.7 per cent, of those operated upon through an abdominal approach survived (Table VI). It appears, therefore that

TABLE VI

	Cases	Lived	Died	Per cent lived
Abscesses of dome of liver	18	12	6	66.6
Abscesses not of liver dome	6	2	4	33.3
Patients operated upon by transpleural route	12	9	3	75.0
Patients operated upon by abdominal route	12	5	7	41.7
Total cases	24	14	10	58.3

the prognosis is better when the abscess localizes to the dome of the liver and when the approach can be made by the transpleural diaphragmatic route

SUMMARY AND CONCLUSIONS

1 Twenty four cases of single pyogenic liver abscess are reported

2 The pathogenesis and symptomatology of single pyogenic liver abscess were discussed and a characteristic syndrome which can in most instances be differentiated from multiple abscesses of the liver and from other diseases was described

3 Further investigation of the mode of origin of the single pyogenic liver abscess was urged in order to determine whether the abscess arises by infection through the portal vein or as seems to be more probable by hematogenous infection by way of the hepatic artery

4 Diagnosis can be established in the majority of cases by careful evaluation of the definite and characteristic set of symptoms and signs.

5 Treatment of the single pyogenic liver abscess is surgical

6 Recoveries were obtained in 58.3 per cent of all cases.

7 Abscess of the dome of the liver approached by a transpleural diaphragmatic two stage procedure, gave a better prognosis than abscess elsewhere in the liver approached through an abdominal route

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THYROID CRISIS

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THYROID crisis is one of the unfortunate medical emergencies, and intensive treatment is often of no avail. The pre-operative use of iodine has reduced considerably the mortality of Graves' disease (exophthalmic goiter) and toxic adenoma (10-12). It was thought by some that iodine would control even the most toxic patients (11). However, this idea is not entirely correct. Lahey stated that in a series of 118 patients treated for goiter in a year's time, the mortality rate from thyroid crisis equalled the post-operative death rate for patients with all types of goiter. The Greenes in a more recent article, described the symptoms of thyroid crisis and emphasized some of the circumstances, even trivial in nature, which may precipitate the condition. They called attention to the interesting fact that occasionally a patient may develop crisis when a recent basal metabolism rate has been within the normal limits. Lahey stated that the mortality of thyroid crisis is high and fatalities may be prevented in some instances by the proper treatment.

In the following study, all the available cases of goiter observed at the University Hospital (Ann Arbor, Michigan) since 1925 were reviewed. There were 123 patients who died as the result of this disease. Those who had serious complicating disease, such as diabetes mellitus, mitral stenosis, etc., were not included in this group. Seventy-two, or about 60 per cent of the 123 deaths followed operation on the thyroid gland. The 51 pre-operative deaths were considered to have been the result of a so called "thyroid storm" or "crisis" and were the object of the following study.

There were approximately twice as many females as males. The average age in each sex group was 50 years. The average first basal metabolism rate after admission was +49 per cent and the lowest was -2 per cent. Slightly more than half of these patients

had either auricular fibrillation or signs of congestive heart failure or both. The remainder presented only subjective symptoms of cardiovascular failure, such as palpitation or shortness of breath, or both.

The patient with a basal metabolism of -2 per cent was of particular interest because of the rarity with which a pre-operative crisis develops under such circumstances.

She was 56 years of age and complained chiefly of weakness, shortness of breath, and palpitation. There had recently been a loss of 35 pounds of weight and the admission weight was 118 pounds. The thyroid was of the large nodular type. Lugol's solution had been administered for a 2 week period just prior to admission. The patient had auricular fibrillation and early signs of congestive heart failure (râles at the lung bases and slight edema of the ankles). She remained fairly comfortable during the first 3 weeks at bed rest and received sedatives and digitalis in adequate amounts. The Lugol's solution was discontinued after admission. During an afternoon of the fourth week she cried constantly and complained repeatedly of a fear that her condition might become worse. That night she slept only a short time, and she did not sleep except for brief intervals, through the following 5 days and nights, in spite of the administration of morphine sulphate 0.016 gram (H) on an average of every 7 hours during the restless period. Rather suddenly on the sixth restless day the pulse and temperature became abnormally elevated and during the succeeding 4 days they continued to rise. The latter finally reached 104 degrees F and the former 150 per minute. Severe diarrhea developed on the last day and the patient expired. No evidence of infection had been observed. The single basal metabolism rate had been taken during the first week in the hospital.

It is suggested that this case represents a so called "withdrawal crisis" brought on by discontinuing the Lugol's solution. Rest had been instituted to improve the cardiovascular status, and a second iodine remission was expected later, had it become necessary as a pre-operative preparation. It seems questionable that continuing the iodine medication would have done other than delay the final outcome. The situation might have been

TABLE I.—OPERATIONS THAT RESULTED IN THYROID CRISIS

Case	Age	B M R	Operation
	20	+34	Kruska
	44	+22	Hysterectomy and B Salpingo-oophorectomy
2	31		Hysterectomy
4	42	+20	Cholecystectomy and appendectomy
5	54		All teeth extracted
6	59	+27	Two cystoscopic examinations

much more favorable if Lugol's solution had not been given before admission to hospital.

For clarity the 51 cases were subdivided into groups depending upon the precipitating factor or factors of crisis as far as it was possible to determine them.

Cases admitted in crisis. A fully developed thyroid crisis had developed in 8 of the 51 patients before admission to the hospital. These patients were either totally irrational or in coma. All were emaciated and dehydrated and the majority died within 3 or 4 days after admission. The more elaborate diagnostic procedures were not done. The erroneous diagnosis of acute encephalitis had been made on one patient and it was not until after necropsy that the true nature of the condition was realized. The findings regarding the presence or absence of acetone or diacetic acid in the urine were not recorded on any of these case records. None of the records of the urinary examinations, however, showed evidence of a glycosuria. Few patients will live who have reached such a marked state of toxicity.

Crisis precipitated by surgical procedure. Six of the 51 patients died as the result of a thyroid storm brought on by surgical procedure, the operations having been directed to correct disease of organs other than the thyroid gland. The operation in each case is charted (Table I). In no instance was the operation a surgical emergency.

This group illustrates the grave danger resulting from such operations. The mild clinical toxicity as was evidenced by the relatively low metabolism rates does not warrant such action regardless of its minor character unless it is thought a life-saving measure.

TABLE II.—INFECTIONS THAT PRODUCED THYROID CRISIS

Case	Age	B M R	Type of Infection
	26	+70	Sore throat (hemolytic streptococcus)
	4		Sore throat (hemolytic streptococcus)
3	34	+40	Sore throat (Bacillus dysenteriae)
4	23		Toothache
5	2		Acute cholecystitis
6	34	+8	Abscess of the abdominal wall
7	26		Femoral thrombophlebitis with pulmonary infarcts
8	29	+27	Chloroform poisoning (Same patient as Case 6, Table I)

Crisis precipitated by infection. As the result of crisis brought on by infection 8 of the 51 patients died (Table II). This group, small as it is, shows a wide variety of infections and should serve to emphasize the importance of their development. It is generally conceded that this type of patient is more susceptible to infection than a normal person. The discomfort produced in these patients as a result of the infection appeared much greater than the nature or intensity of the infection would lead one to expect, and in all instances was not relieved even with opiate. It would appear to follow that under such circumstances there is an increased opiate tolerance.

Crisis precipitated by therapeutic and minor diagnostic procedures. In 9 of the 51 patients it appeared possible that crisis was precipitated by a therapeutic or diagnostic procedure (Table III). In all instances except those cited below these were preceded by an appreciable period of restful days and nights. The premonitory symptoms of crisis (nausea, anorexia, vomiting, diarrhea, marked restlessness, great emotional instability, etc.) were of prompt onset and of short duration following the procedure. Total irrationalism, muttering delirium or coma accompanied by a rapidly rising pulse temperature, and respiratory rate occurred within 24 to 48 hours. The 2 patients charted as having digitalis intoxication were the exceptions. By 1 of these patients (Case 4) 33 asymptomatic days had been spent at rest in bed. A mild sinus tachycardia had persisted. During the last 3 days the patient received 21 grams of the

TABLE III.—THERAPEUTIC AND DIAGNOSTIC PROCEDURES THAT WERE FOLLOWED WITHIN 24 TO 48 HOURS BY SEVERE CRISIS

Case	Age	B.M.R.	Procedure
1	30	Unsatisfactory	Abdominal paracentesis
2	33	+63	Thoracostomy
3	45	+47	Spinal puncture
4	48	+70	Digitalis intoxication
5	48	Unsatisfactory	Digitalis intoxication
6	46	+39	B.M.R. determination
7	40	+31	B.M.R. determination
8	70	+80	B.M.R. determination
9	44	+74	B.M.R. determination, electrocardiogram and chest X-ray (see day)

equivalent of the powdered leaf of digitalis 1.1 grams was the calculated theoretical dose. Shortly after the last dose had been given the patient vomited and the pulse rate rapidly increased to 132 per minute. Death occurred within a few hours. In the other patient (Case 5), there had been a recent fracture of the neck of the femur, initiating severe Graves' disease. Digitalis was given in an attempt to control the sinus tachycardia. At the time the patient had received 0.2 gram of the equivalent of the powdered leaf of digitalis in excess of the calculated theoretical dose the heart rate increased from 110 to 180 per minute. The temperature and respirations remained about normal. In a further effort to control the tachycardia the drug was continued. By the end of a 14 day period the patient had received 6.7 grams of the equivalent of the powdered leaf—almost three times the theoretically calculated dose. An electrocardiogram at that time showed evidence of digitalis intoxication, rapid ventricular rate, and ventricular escape. The patient had not spent a restful night after the second day in the hospital and yet had received morphine sulphate 0.016 gram (H) on an average of every 7 hours as a supplement to routine sedatives.

Taken as a whole, the findings of this group would seem to point to a narrow margin of safety between restful improvement on the one hand and crisis on the other. It would also seem probable that even slightly aggravating procedures should be withheld whenever pos-

sible, even though the objectives are considered beneficial in the average patient. The highly toxic state would seem to contra-indicate all diagnostic procedures which are not distinctly imperative for the patient's immediate welfare.

There were 125 procedures on the entire group of 51 patients which might have been delayed until a more favorable time. There were 22 successful first basal metabolism determinations and 12 unsuccessful first trials. To attempt a basal metabolism determination on a highly toxic thyroid patient is often of very little diagnostic value and at the same time may be an added risk to the patient's life.

Patients in whom earlier or more intensive treatment may have averted crisis. Nineteen of the 51 patients were classified in this group, making it the largest single division. There were 11 of these 19 patients in whom insomnia alone accounted for the more severe symptoms of crisis that finally developed. These 11 patients spent an average of 8 consecutive almost sleepless nights and days before the more severe symptoms appeared. For this restless period they received an average of 0.016 gram of morphine sulphate¹ (H) on an average of every 42 hours. Other sedatives (barbital chloral bromide etc.) were routinely used but failed to induce sleep in these patients. The value of sleep could not have been appreciated sufficiently in some of these older cases.

Table IV shows the dosage of Lugol's solution as given to these 11 patients. When Lugol's solution was given it was administered on an average of 0.3 cubic centimeter three times a day. Had the drug been started when the premonitory symptoms of crisis appeared, each patient would have received an average of 10 cubic centimeters by the time of arrival of the more severe symptoms. It seems possible that the iodine medication was delayed too long to have been of much benefit to these patients.

Of the remaining 8 patients in this group, 6 developed diarrhea accompanied by an average of 5 consecutive almost sleepless

¹Morphine sulphate and pentopon were the only opiates used. When pentopon was used 0.07 gram was calculated as equivalent to 0.016 gram of morphine.

TABLE IV—LUGOL'S SOLUTION AS ADMINISTERED TO ELEVEN PATIENTS

Case	Age	B. M. R.	Lugol's solution (c.c.m.)
1	31	+33	3
2	48	Unsatisfactory	3
3	46	Unsatisfactory	13
4	54	Unsatisfactory	
5	63	+31	6
6	55	Unsatisfactory	
7	48		6
8	66	Unsatisfactory	
9	70	+66	5
10	54		
Average			6.7 c.c.m.

nights and days before the more severe symptoms of crisis appeared. Lugol's solution as given to these patients is charted (Table V).

The 3 patients left in this group of 19 developed nausea and vomiting as early symptoms of crisis.

This group illustrates emphatically the imperative necessity of rest. Diarrhea was finally controlled in every instance except 1 with either paregonic or tincture of opium. However as a result of this symptom frequent bed changes were necessary and rest was disturbed.

In the group of 51 patients, excluding those admitted in crisis, there was a surprisingly large number of consecutive almost sleepless hours before the more severe symptoms of crisis. This figure gave approximately 128 such hours per patient for which each received an average dose of morphine sulphate 0.016 gram (H) on an average of every 41 hours.

TREATMENT

Recognition of impending crisis. Sleepless nights, diarrhea, anorexia, nausea, vomiting, marked sweating, and great emotional instability form an important group of early symptoms, and their occurrence in a toxic thyroid patient should arouse strong suspicion of impending crisis. They prevent rest and dehydrate the patient. With few exceptions, two consecutive sleepless nights were

TABLE V—LUGOL'S SOLUTION AS ADMINISTERED TO SIX PATIENTS

Case	Age	B. M. R.	Lugol's solution (c.c.m.)
1	44	+74	4
2	55	+90	
3	56	+66	17
4	63	+56	30
5	64	+66	
6	50	+46	
Average		+73	7 c.c.m.

followed by uncontrolled restlessness until the more severe symptoms of crisis appeared. Usually there were warning symptoms of impending crisis. In 5 instances an increase in the average respiratory rate of at least 5 cycles per minute was the earliest discoverable indication. Weight loss should always be taken into account. The average weight loss in these 51 patients was 42 pounds in a time frequently less than several months before admission. It is an absolute necessity to estimate clinically the severity of the hyperthyroidism and the reserve power of the patient to withstand the strain. The wide variation in the metabolic rates on these patients would tend to reduce their importance in evaluating the toxicity and contribute nothing to an estimation of the patient's reserve. Every clinical feature must be taken into consideration: the duration of the disease, the weight loss, the admission weight, the age, the degree of circulatory failure, the pulse rate, the gastrointestinal status, the degree of dehydration, the amount of acidosis if present, the stability of the nervous system, the metabolism rate, the temperature, every complicating disease, especially infection, and finally the amount of previous iodine medication.

Impending crisis can be treated with a fair degree of success. When the crisis has been fully established, however, the mortality will be high in spite of any type of treatment yet known. In this series of cases infection was the only theoretically unavoidable precipitating factor and yet it played a rôle in only 15 per cent of the deaths. An alertness for the possibility of impending crisis, together with a keen regard for its premonitory symp-

toms and modes of precipitation should avoid its development in the majority of cases

MANAGEMENT

The highly toxic thyroid patient should be regarded as an emergency case. The patient should be placed immediately in a quiet room unoccupied by another patient who may cause disturbances of any sort. A ward bed is out of the question. The routine history taking and examination should be restricted to a minimum. Diagnostic procedures that are not essential for the patient's immediate welfare should be delayed until a more favorable time. A special nurse is highly desirable when restlessness is difficult to control. These patients attempt to walk about, sometimes fall out of bed and become very nervous unless constant nursing care is provided.

Sedatives and narcotics. Absolute rest especially at night, must be obtained if satisfactory results are to be expected. The most dangerous period appears to be the first week or ten days of hospitalization. New surroundings and anticipation of a major operation undoubtedly play a contributory part. There was a tendency to give insufficient doses of opiate to these patients as illustrated by the group under consideration in whom satisfactory rest was not obtained. Relatively large quantities of opiate are required to relieve the classical symptoms, and the dosage should be an amount sufficient to relieve these symptoms and obtain the much needed sleep. Hypnotics such as luminal, barbital, chloral, paraldehyde and amytal¹ are of great value as a routine medication and frequently will control the restlessness without additional medication. When they fail to do so, however, one should not hesitate to supplement them with the opiates such as pantopon or morphine. A very restless patient may require pantopon 0.02 gram (H) as often as every 30 minutes for several doses before sleep is obtained. A dangerously low respiratory rate should be the only warning to stop such medication before the desired result is reached.

Fluids. It was impossible to estimate the average daily fluid intake of the 51 patients

¹This drug has been found very effective when given intravenously.

However a 3,000 cubic centimeter daily minimum should be maintained. If nausea or vomiting should diminish the intake by mouth, one should resort immediately to the subcutaneous or more preferably the intravenous route.

Glucose. These patients develop acidosis rapidly if the carbohydrate intake is curtailed (6). The carbohydrate reserves are diminished in all patients with toxic thyroid disease (15) and the high metabolic rate makes necessary the ingestion of abnormally increased amounts of carbohydrate to prevent acidosis. If acetone or diacetic acid is present in the urine there is urgent need of glucose. Glucose unquestionably provides an immediate available source of carbohydrate. Since the glucose storage in these patients is very likely to be impaired, it would seem more practical to give it slowly in the form of a 5 per cent solution, rather than by repeated injections of a hypertonic solution. This avoids transient hyperglycemia with its resultant dehydrating action on the tissues, and the diuretic effect and unnecessary waste of glucose through the kidneys. That there is a rapid utilization of carbohydrate by patients with toxic thyroid disease has been determined by studies of the respiratory quotient (6). Therefore it would seem unnecessary to give insulin, although it has been advised and used with no untoward effects.

Iodine. From a therapeutic viewpoint it is well to consider impending thyroid crisis a condition of impending dehydration and acidosis, and to depend upon the administration of iodine alone, even for a short time, is a serious mistake. If iodine is to be used it should be started when the premonitory symptoms of crisis appear.

In the majority of patients with Graves' disease (exophthalmic goiter) the administration of iodine will result in a remission of toxic symptoms provided it has not been given previously (10, 12). With these patients the incidence of remission is not as high and the remissions are not as striking in goiter areas as elsewhere (4). This is probably due to the popular use of iodine in many forms in goiter areas (13). It has been reported that almost half of the patients with so called toxic

adenoma will show a moderately favorable response to iodine medication if not made refractory by previous iodine drugging (4). Iodine therefore is essential in the treatment of impending thyroid crisis as well as in the pre-operative preparation of these patients. Its indiscriminate use is not wise in patients who might remain too toxic for safe operation at the end of the period of expected iodine remission unless the danger of impending crisis compels its use. Occasionally this becomes a fine point of judgment. The vast majority of these patients will improve on bed rest, sedative drugs, and a favorable environment. In patients who do not seem in danger of impending crisis but who are too toxic for reasonable surgical risk it would seem wise to withhold iodine for a period of days, weeks or even months and thus reserve the iodine remission for an immediate pre-operative preparation at a more favorable time. In patients who can take iodine by mouth, Lugol's solution may be given in 1 cubic centimeter doses daily. If there is nausea or vomiting Lugol's solution may be given intravenously well diluted with the fluids, in doses of a cubic centimeters daily.

Iodine would play a much more important part in the treatment of toxic thyroid patients if so many were not made either partially or totally refractory to the drug by previous attempts at cure with its use. It is the general opinion of the medical staff at this hospital that the toxic thyroid patients who have not received iodine before admission to the hospital for operation are still relatively few in spite of the common knowledge that all iodine remissions are of temporary character. The failure of an iodine remission to take place in face of an impending thyroid crisis may cost the patient's life. Preliminary iodine drugging during the few weeks just prior to admission to the hospital for operation is not advocated. Indiscriminate iodine administration to patients immediately on admission to the hospital for operation appears unjustified.

Digitalis. In no instance in the series of 51 patients was full theoretical digitalization or overdigitalization followed by a decrease in the pulse rate. In 4 patients incomplete theoretical digitalization was followed by an

appreciable decrease in the pulse rate. However this last observation was confused by rest in bed. It may be concluded by such findings that full digitalization of highly toxic patients is not likely to be attended with an appreciable slowing of the pulse rate. Digitalis should be given however to all toxic thyroid patients who have auricular fibrillation since in a great majority of such patients a beneficial effect will occur. Barker et al found an average decrease in the pulse rate of 20 beats per minute in a group of 108 toxic thyroid patients with auricular fibrillation. From the observations on 2 cases reported in this paper overdigitalization appeared extremely harmful. In rare instances the toxic thyroid patient will be found intolerant of the average amount of digitalis and a thyroid crisis may be precipitated (16). Usually toxic thyroid patients have an increased tolerance to digitalis in the neighborhood of 134 per cent (3). Digitalis should be given to all toxic thyroid patients who have or have not auricular fibrillation and who have definite cardiac enlargement or signs of congestive heart failure, since these patients are very likely to have a complicating factor of cardiovascular disease either hypertension or arteriosclerosis more rarely rheumatism or syphilis (2, 14). Full pre-operative digitalization of patients in this particular group who do not have auricular fibrillation may prevent an unnecessary period of cardiac strain should fibrillation develop during or shortly after operation as is frequently the case.

The conversion of auricular fibrillation to normal rhythm by the use of quinidine sulfate is best reserved as a postoperative measure (1, 3).

This statement is frequently disputed on the grounds that there is a lower mortality rate in patients who go to operation with a normal rhythm than in those who attend operation with auricular fibrillation. It should be remembered that the abnormal rhythm is but a single evidence of a generalized toxicity and that its alteration does not affect the patient's general condition. There is slight mechanical advantage of the efficiency of the normal rhythm over that of auricular fibrillation controlled with digitalis but this advan-

tage must be balanced against the dangers of quinidine therapy in the more toxic patient against the chance of false security on the part of the surgeon, against the probable return of the auricular fibrillation during or shortly after operation and finally against the trouble of reconversion with further quinidine should such be necessary.

There has been little emphasis placed on thyroid crisis in the current literature. Lahey has repeatedly called attention to the importance of this condition. Co-operation from all sides together with a better understanding of these highly toxic patients is needed if the pre-operative mortality is to be reduced to a minimum.

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THE PRESENT STATUS OF BLOOD EXAMINATION IN THE DIAGNOSIS OF SURGICAL INFECTIONS

WITH A STUDY OF TWENTY SEVEN INDICES OF INFECTION REPORTED IN THE LITERATURE

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WITHIN recent years there has arisen a tendency to distrust the value of total and differential blood counts in the diagnosis of surgical infections. In many instances this lack of trust is well founded as cases of overwhelming peritonitis with normal total counts are only too common, as are cases of severe sepsis with polymorphonuclear leucocyte percentages varying all the way from zero to one hundred. Because of this lack of certainty in the interpretation of the conventional counts, variations have been devised so many in fact that in the present article the writer reviews twenty seven such methods.

When the surgeon is confronted with such a multitude of methods he is apt to abandon all of them. Furthermore and quite important, many of these methods were devised by hematologists who are not surgeons and the methods were not originally intended for the diagnosis of surgical infections. The surgical infections are somewhat peculiar to themselves and only certain hematological procedures are most suitably applied to them. It is the purpose of this paper to analyze the various methods of blood examination and determine which are most applicable to the diagnosis of surgical infections. By the term surgical infection is meant septic processes such as acute appendicitis, acute peritonitis, septic arthritis, pyogenic abscesses and similar conditions. The diagnosis of these infections is of prime importance for they are by definition conditions in which surgical treatment is indicated.

CLASSIFICATION

It is possible to classify the methods as follows

- 1 The total leucocyte count
- 2 The conventional differential count.
- 3 Various indices of proportion between the total leucocyte count and the differential count
- 4 Methods that take the nuclear changes in the polymorphonuclear neutrophils into consideration
 - (a) Arnet's "shift to the left" and its modifications.
 - (b) The Schilling hemogram and its modifications.
- 5 Cytoplasmic toxic granulations
- 6 Sedimentation rate of the erythrocytes
- 7 Miscellaneous reactions.

I THE TOTAL LEUCOCYTE COUNT

From the time of the first total leucocyte count by Malassez in 1872 the variations in the count have been studied in all sorts of conditions. Sadler in 1892 noted the increase of leucocytes in infections and Cabot in 1894 in a study based on 332 blood counts discussed the leucocytosis of appendicitis, peritonitis, and other infections. Smith (1913) and others have propounded the view that a high leucocyte count is a bad sign, but many exceptions to this rule have been observed. Koritschoner (1927) in comparing the total leucocyte count with the pathological report in 170 operated upon appendices found 4 of 57 acute cases below 10,000 and 29 of 96 chronic cases above 10,000. He believes the high count in the chronic cases is due to the elements of fear and the stress of admission to the hospital. In no condition does the total leucocyte count so misrepresent the actual state of affairs as in septic granulopenia which has been shown by the writer (1931-1932) and by others. Pincy (1926) states that the size of a leucocytosis is not of prime importance just as the size of a tumor can give little information as to its nature.

The total leucocyte count is known to vary extensively under normal conditions Goldscheider and Jacob (1894) first discussed distribution leucocytoses Sabin Cunningham Doan and Kindwall (1925) find an approximately hourly rhythm of the leucocytes all cells not being affected alike Arneth and Ostendorf (1923) say the average rise in the total leucocytes in digestion leucocytosis is 35 per cent, the rise affecting the polymorphonuclear leucocytes to the greatest extent and the Arneth shift very little Garrey and Butler (1929) deny the presence of a digestive leucocytosis, but show that running a quarter of a mile will raise the total leucocyte count to 35,000 in a normal individual and that pain may raise it to 20,000 in a subject resting in bed and be mistaken for infection Shaw (1927) advances the view that the leucocytes of man exhibit twice daily a tidal rhythm of about 12 hours' duration which is independent of certain recognized physiological stimuli From these results in normal persons it is seen that the total leucocyte count may often be misleading in surgical infections Furthermore, the use of a series of hourly counts in determining the indication for operation in doubtful cases of appendicitis may merely record physiological changes rather than the progress of the infection

2 THE CONVENTIONAL DIFFERENTIAL COUNTS

It is generally recognized that in the pyogenic infections the percentage of polymorphonuclears increases However as has been pointed out by the writer and others in septic granulopenia the polymorphonuclear percentage falls to zero Furthermore Boies (1931) states that this percentage can vary from 56 to 78 per cent in an hour Despite these obvious objections to the use of the conventional Ehrlich differential in the diagnosis of surgical infections the changes of several of the constituent cells are of importance including the eosinophiles, lymphocytes monocytes, and the macropolycyte These are briefly considered in the following paragraphs.

Eosinophiles The increase of eosinophiles in allergic conditions and parasitic infections is a well known phenomenon but the aneosinophilia of acute pyogenic infections is a

less well known although no less definite occurrence Page, Turner, and Wilson (1928) discuss eosinophilia in 5,500 medical cases while Jones and Crocker (1927), Baum (1929) Schilling (1929) and Allen (1930) have noted the aneosinophilia of acute surgical infections and the reappearance of eosinophiles during recovery Allen states that a basophilia indicates loss of resistance Sours (1932) has observed in appendicitis "that if an aneosinophilia persists past the sixth postoperative day, the infection usually overcomes the patient"

Lymphocytes and monocytes and the lymphocyte/monocyte ratio The diagnostic value of these cells is presented first in the dictum advanced by Schilling (1924, 1932) that every pyogenic infection has three phases, the polymorphonuclear leucocyte defense stage the monocyte stage of recovery, and the lymphocyte stage of cure, and, secondly is shown also by the lymphocyte/monocyte ratio Sours says that in an ordinary case of appendicitis going on to recovery the monocytic response starts about the third day and reaches its height about the seventh day The lymphocytic phase occurs about the seventh to the tenth day In general it appears that while the lymphocyte/monocyte ratio may be of value in tuberculous and other chronic infections it is of only secondary importance in the diagnosis of surgical infections

The macropolycyte This cell, while not included in the original Ehrlich differential is considered to be of much diagnostic import by Cooke and Ponder These authors (1927) state "The macropolycyte is of grave prognostic import, and in our experience no patient has lived beyond a few days from its appearance in the peripheral blood" The writer believes that the megacaryocytic type of macropolycyte appears too irregularly in the blood stream to be used in the diagnosis of surgical infections, but when considered in conjunction with other blood changes may be of some value in prognosis

3 VARIOUS INDICES OF PROPORTION BETWEEN THE TOTAL LEUCOCYTE COUNT AND THE DIFFERENTIAL COUNT

Both the total leucocyte count and the differential count when used alone have so

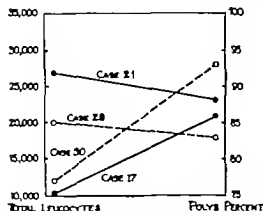


Fig. 1 The Gibson standard chart. An ascending line is supposed to indicate a poor prognosis and a descending line a good prognosis. The four lines in the above graph represent four cases studied by the writer. The two solid lines are from blood counts taken just before operation in two non-fatal cases of appendicitis. The two broken lines are from blood counts taken the day of death in 2 cases of pelvic peritonitis. These 4 illustrative cases indicate the fallibility of the Gibson chart in diagnosis and prognosis.

frequently given misleading information that a correlation of the two was suggested. Sondern (1905) stated that he had observed in personal work with 5,000 blood examinations.

In all cases of which I have a clinical record no pus or gangrene was ever observed with a polynuclear percentage below 70. Eighty-five per cent or over of polynuclear cells I have never seen without a purulent exudate or gangrenous process irrespective of the leucocytic count and only one case over 94.5 per cent did not end fatally. Septic granulopenia is an obvious exception to the first of these two rules of Sondern.

The Gibson standard chart. Gibson in 1906 interpreted this postulate in graphic form as is seen in Figure 1. Gibson considered the normal total leucocyte count to be 10,000 or less and the normal percentage of polymorphonuclears to be 75 per cent. For every rise of 5 per cent in the latter there should be a corresponding rise of 5,000 in the former. If this rise in the total leucocyte count does not occur the line rises and the prognosis is bad. If the line descends the prognosis is good. Menninger and Heim give an extensive literature on the Gibson standard chart and find a fairly good correlation with the findings in their 309 cases of appendicitis as do Neal and Robnett in their 227 cases of appendicitis.

Walker's index of resistance. Walker in 1919 devised his index of resistance (IR)

$$IR = (T - 10) - (P - 70) = T - P + 60$$

where T equals the thousands of total leucocytes and P equals the percentage of polymorphonuclears. Walker used this index in 105 cases. A positive index is a good omen but often there is a positive antemortem index. Middleton and Gibbon (1930) modify Walker's index by using seventy five instead of seventy in the equation.

The lymphocytic index. Jones and Crocker (1927) use a lymphocytic index computed like Gibson's. McDonald (1931) represented this index by the equation

$$IR = (T - 10) - (20 - L) = T + L - 30$$

where T equals the thousands of total leucocytes and L equals the percent of lymphocytes.

Watters (1913) charts the leucocyte count by a solid line and the polymorphonuclear percentage by a broken line on Gibson's chart. The solid line should remain above the broken one.

Absolute values. Absolute values for the counts of the different cells found in the differential have been advocated by Boerner (1930), Middleton and Gibbon (1930) and Kolmer (1931). Reznikoff states that absolute values are of much less value than the percentage determinations because of the great variation of the total count in different phases of pathological conditions.

NUCLEAR CHANGES IN POLYMORPHONUCLEAR NEUTROPHILES

4a. Arnet's shift to the left and its modifications. When it was noticed that the total leucocyte count and the differential count alone and in many instances a combination of the two did not give true information as to the presence of an infection, hematologists sought other methods. Arnet (1904) working at the Leube clinic was one of the pioneers in this field basing his observations on the age of the polymorphonuclears. Several observers had previously noticed the correlation between nuclear immaturity and infection. Muir (1891) states. Also when there is leucocytosis, especially if acute, there are

found more intermediate forms between the two varieties (polymorphonuclears and lymphocytes), and there are proportionately fewer corpuscles in which the nuclei are quite separate from one another i.e., in suppuration etc. a greater number of the corpuscles appear to be of younger age or more recent formation." Ewing (1901) finds many myelocytes with the polymorphonuclear leucocytosis of infectious diseases. It remained for Arneth to analyze minutely these changes. He divided the polymorphonuclear neutrophiles into five classes depending on whether the nuclei have one to five lobes. These classes were divided into subclasses so that in all 21 individual types of polymorphonuclear neutrophiles were counted. The normal figures for the different classes in one hundred polymorphonuclear neutrophiles are

Class	I	II	III	IV	V
Number of cells	5	35	41	17	2

Since this was always charted in this form an increase of the cells of type I is a shift to the left and an increase of the multinucleated cells of Class V is a shift to the right. A shift to the left occurs in infections and a shift to the right in pernicious anemia.

The chief objection to the Arneth count is its complexity. This makes it more readily applicable to chronic conditions as tuberculosis where the expenditure of much time is not a handicap. In the rapidly changing events of a busy surgical service a lengthy procedure as the Arneth count finds little place. Furthermore, as will be shown later most of Arneth's subdivisions of the polymorphonuclear neutrophiles are in the more mature cells which are affected by such slight changes that their alteration is of little value in the more severe type of surgical infection.

The polynuclear count The polynuclear count of Cooke and Ponder (1927) is one of the most popular of these simplifications. These authors neglect the subclasses and consider only the five main classes. The normal values of the polynuclear count are not quite the same as for Arneth's five classes.

Needles neutrophilic graph Needles (1932) introduced a graph wherein he charts the normal line of Cooke and Ponder's five classes then using a point between the second

and third classes as a fulcrum obtains clockwise (left according to the old classification) and counterclockwise (right) shifts.

Counting the nuclear lobes Von Bonsdorff (1913) devised the method of counting the nuclear lobes in one hundred polymorphonuclear neutrophils. Von Bonsdorff found the normal value to be around 280 in men and slightly less in women.

The weighted mean This term was devised by Cooke and Ponder to designate the mean number of nuclear lobes per polymorphonuclear neutrophile. This is equal to the number of nuclear lobes divided by the number of cells and should be above 2.4 in normal individuals. Piney (1929) finds the weighted mean in health varies from 2.47 to 3.11 with an average of 2.74.

The Bushnell and Treuholtz index These authors (1908) add the number of cells in Arneth's Classes I and II and half of those in Class III. The normal average index by this method is 67.

The Henson index Henson (1914) states that the normal summation of Arneth's Classes I and II is forty cells. He uses as his index the excess of this summation over normal. Thus fifty cells would be a +10 index and indicative of infection.

4b *The Schilling haemogram and its modifications* Schilling simplified Arneth's count by dividing the polymorphonuclear neutrophils into four classes: myelocytes, young forms, staff forms, and segmented or adult forms. Since he combines small and large lymphocytes into one group and both of Ehrlich's types of monocytes into one group and since Ehrlich had already given myelocytes a separate grouping, Schilling's eight types of cells as shown in Table I are no more in number than the conventional Ehrlich count. As will be shown later, Schilling's contribution is that his subdivisions are those that are of most practical value. Weiss (1931) says in this connection that "the actual significance of the percentage of neutrophils lies in one of its component parts, the percentage of staff or immature neutrophils. Once this is understood all of the apparent discrepancies can be solved." The differentiation between segmented and non-segmented polymorphonuclear

clears is of prime importance in the diagnosis of primary infections, while the subdivision of lymphocytes into small and large varieties is of little practical value except in one disease lymphatic leukemia.

The writer puts the upper limits of normal of the total leucocyte count and the staff percentage higher than does Schilling.

TABLE 1 THE SCHILLING HÆMOGRAM

	WBC	E	B	My	J	S	A	L	M
Normal ranges	5,000-10,000	4				1-6	1-7	25	6
Normal average	8,000	5	5			5	6.5	5	6

WBC = total leucocytes to count
 E = eosinophiles
 B = basophiles
 My = myelocytes
 J = juveniles
 S = staff cells
 A = adult polymorphonuclear neutrophiles
 L = lymphocytes
 M = monocytes

In surgery the Schilling hemogram seems to be peculiarly adaptable. It has been used by Allen (1930) Lippincott (1930) Thompson (1930) Miller (1932) and Kilbury (1932). Kolmer (1931) says "I strongly advise surgeons to adopt this shift to the left and nuclear index method for routine differential leucocyte counts and reports." Connor (1931) in discussing blood pathology in relation to surgery says "the Schilling hemogram bids fair to become a valuable procedure in diagnosis and prognosis." Goodale and Manning (1931) compare the hemogram with the microscopic findings in a series of 40 operated upon appendices and finds the agreement very good. Yaguda (1931) in a study of 671 pathologically examined appendices finds the hemogram much superior to Gibson's line and concludes "In the presence of a normal immature count I agree with Cooke that an inflammatory process in the appendix can be definitely excluded."

Reznikoff (1929) points out that the total count lags behind the hemogram findings. Furthermore in 30 fatal pneumonias 57 per cent had a total leucocyte count below 10,000 but all had more than 10 per cent non-segmented polymorphonuclear neutrophils. Yaguda says that physiological leucocytoses do not affect the percentage of non-segmented cells. Schilling (1924) shows that there is some daily variation in this percentage in normal

individuals but that it is not so marked as the variation in the total leucocyte count or the percentage of polymorphonuclears. Harter and Lyons (1933) state that moderate exercise and emotion give neutrophilia without shift, but that a severe stress gives also a shift. Doan and Zerfas (1927) in discussing the rhythmic range of the white blood cells show that the shift to the left does not vary as much as the total counts. Baum (1929) believes in serial hemograms which are taken at regular intervals.

Pons and Krumbhaar's classification Pons and Krumbhaar (1924) attempted to simplify Schilling's hemogram by using only three classes:

- Class I = metamyelocytes
- Class II = staff cells
- Class III = segmented cells

However since these authors also counted the myelocytes separately in reality they have as many subdivisions of the polymorphonuclear neutrophils as Schilling.

Non filament counts The most extreme simplification of the original Armeth scheme is to divide all polymorphonuclear neutrophils into filamented (segmented) and non filamented (non segmented) forms. Even this simple procedure was attended with much argument. There was debate concerning the names given these two groups and concerning whether to consider the percentage of non filamented forms as that of one hundred leucocytes or one hundred polymorphonuclears. Kothe (1908) used the percentage of mononucleated polymorphonuclears in one hundred leucocytes. Schilling (1929) speaking of the percentage of non filaments in one hundred leucocytes as opposed to the use of the complete hemogram says the non filament percentage "is of interest only within the narrow limits of one disease (appendicitis) and gives a classification:

Percent	Degree shift
11-25 non-filaments	= 1st
25-35 non-filaments	= 2nd
45-60 non-filaments	= 3rd
more than 60 non-filaments	= 4th

Nuclear index Gerard and Boerner (1930) and Boerner (1932) present a method of expressing the non filament count. The nuclear

index of these authors should be over fifteen in normal persons (average 36.6), whereas children younger than 1 year of age average 28.1. The nuclear index (NI) is calculated on the basis of one hundred leucocytes and expressed as

NI = Filamented polys
Non filamented polys
15-17 = normal
10-15 = slight shift
5-10 = moderate shift
0-5 = severe shift

The *Schwarzbart chart* Schwarzbart (1931) has represented all the elements of the hemogram in a very graphic way. He has vertical scales for each cell type running from left to right. These scales are so adjusted that an equal vertical change in one cell type corresponds to an equal vertical change in another. A heavy line across the center of the chart represents the normal average and lighter lines above and below the normal ranges of each type of cell.

5 CYTOPLASMIC TOXIC GRANULATIONS

Cytoplasmic criteria of the age of leucocytes in normal individuals are extensively used by hematologists. The evidences of immaturity include mitochondria and amœboid activity in supravital preparations, cytoplasmic basophilia and the presence of centrosomes and the Golgi apparatus. Fitzhugh (1932) believes that the best criterion of immaturity is the presence of cytoplasmic granulations. Young neutrophils have more basic staining granules scattered in with the neutrophilic granules than do mature forms. In the latter the specific granulation is amorphous or slightly acidophilic in character.

Kugel and Rosenthal have devised a degenerative index

$$\text{Degenerative Index} = \frac{\text{Degenerated polymorphonuclears}}{\text{Total polymorphonuclears}}$$

and state that "the persistence of a degenerative index between 90 and 100 per cent is of grave prognostic import and usually followed by death.

Prochnow (1931) analyzes several cases of appendicitis with simultaneous Schilling and pathological granulation charts and finds the

hemogram much better. In pneumonia the peak of the pathological granulation curve appears after the crisis. In conclusion Prochnow states "*Laesst sich wohl feststellen, dass die Hamogrammehode in der Diagnose und Prognose der akuten Appendicitiden ein viel empfindlicheres und verlässlicheres diagnostisches und prognostisches Mittel bildet als die Prozentzahl der pathologischen Granulation*".

6 SEDIMENTATION RATE OF THE ERYTHROCYTES

This test was introduced by the obstetrician Fåhræus in 1918, although Grodinsky has pointed out that several previous observers had noted the rapid settling of the erythrocytes in pathological bloods. Partly because the test was introduced by an obstetrician and partly because the range of delicacy of the test is peculiarly adapted to obstetrical and gynecological cases the sedimentation rate has been chiefly applied in these fields.

Wintrobe (1933) presents a new instrument whereby one can determine the sedimentation rate, volume of packed red cells, leucocytes and platelets and icteric index at the same time. A perusal of the literature indicates that the sedimentation rate is not so applicable to the diagnosis of surgical infections as are the hemogram and nuclear indices. Schilling (1929) states in this connection that "the acute infection or exacerbation, the progressive and more active process is reflected in the hemogram, while the latent chronic infections sometimes are better expressed in the sedimentation reaction." Varga (1929) after discussing the effects of various factors on the sedimentation rate concludes "*Die Untersuchung der Senkungsgeschwindigkeit hat uns sowohl in diagnostischer als auch in prognostischer Hinsicht viel weniger zu sagen als das Blutbild*".

7 MISCELLANEOUS REACTIONS

Changes in the serum. The series of tests used collectively by McDonagh have so far been applied only to chronic conditions. These tests include an observation of the colloidal dispersion of the blood under the ultra microscope, determinations of blood sugar

urea, viscosity and refractive index. From the results of these determinations bloods are divided into hydrated normal, and dehydrated varieties and treatment given accordingly. The writer will not attempt to give an appraisal of these tests except to say that at present they have little application to acute surgical infections.

Leucocyte reaction of D Amato. This reaction was introduced by D Amato in 1921 and was derived from Widal's haemoclastic crisis reaction. It was first applied to tuberculosis, later to various types of infections and in 1927 to syphilis. At present the reaction has no application to surgical infections.

Iodophilic. Locke (1902) noticed that blood in inflammatory conditions gave a reaction with iodine. The presence and intensity of this reaction have been used in diagnosis. At present this method is little used.

The guttadiaphot. The guttadiaphot as used by Schilling and others consists in applying drops of venous blood directly from a syringe to three strips of paper of different color which are held in a frame of cardboard and examined the next day. By the corona of color formed around the drops of blood the diagnosis is made. At present the method has no surgical applications, being used only in chronic infectious diseases.

STUDY OF CASES

The writer has used the Schilling haemogram in a series of 33 cases during the past year. The cases to which the haemogram was applied were selected in most instances because of some difficulty in the clinical diagnosis. This small series has the merit that it includes every case in which the haemogram was used by the writer during this period of time. These cases are presented as illustrations of the merits and limitations of the haemogram.

The writer uses an index called the toxic index (TI) which is based upon the Schilling haemogram. This index may be defined as

$$TI = \frac{10My + 5J + 2(S - 10)}{10L + 2L + A}$$

where My = myelocytes, J = juveniles, S =

excess of staff forms over ten (the arbitrary upper limit of normal) E = eosinophiles, L = lymphocytes and A = adult polymorphonuclear neutrophils. The multiplication factors for each cell type were arrived at arbitrarily and are considered to represent the relative importance of these respective cells. The index is zero in normal persons and by definition cannot be negative. It is positive in infections.

Toxic index 0.00-0.25 = mild infection

Toxic index 0.25-1.00 = moderate infection

Toxic index 1.00 and above = severe infection

This index is essentially a method of expressing the Schilling haemogram by one arithmetical figure. It is quite probable that the formula can be improved upon. At present it fails entirely to indicate the true condition in septic granulopenia and to a certain extent is inadequate in parasitic infections. Originally this index was termed an index of infection but since it may be markedly positive in non-infective toxic conditions as will be shown later the designation toxic index seems preferable.

In Table II are presented the temperature readings and blood findings in 5 cases. In all 5 cases the haemogram and the toxic index were essentially normal and subsequent events proved that there was no indication for operative interference from the standpoint of infection alone.

CASE 1 represents an instance of suspected acute appendicitis, but further history indicated acute alcoholic gastro-enteritis which was confirmed by the negative blood findings. Case 2 represents renal colic with a high total leucocyte count but normal haemogram. After a brain tumor removal, the question as to whether the persistent fever was of central or infectious origin arose in Case 3. The normal toxic index was substantiated by a subsequent uneventful convalescence. Case 4 represents an instance of Pick's pericarditic pseudo-diphtheria in which despite fever and a high total leucocyte count the haemogram indicated no infection and at operation no signs of inflammation were found. Case 5 represents a man aged 60, with an infected wrist wound, lymphangitis, and axillary lymphadenitis. Because of the patient's age, a serious outcome was feared, but the blood findings and extremely mild subsequent course were concordant.

It is seen from Table II that in 5 cases with normal haemograms there was no surgical infection. That the converse is not always

TABLE II.—NORMAL HÆMOGRAM IN FIVE CASES WITHOUT SURGICAL INFECTION¹

No.	Diagnosis	T	W B C.	E	B	My	J	S	A	L	Mo	Tt
1	Enteritis	98	6,000	1	0	0	0	11	45	40	5	0.01
	Renal colic		18,000		0	0	0	9	77	5	8	0.80
3	Brain tumor	101	15,000	1	2	0	0	9	39	46	1	0.01
4	Polyseroma	99	17,000	7	0	0	0	11	54	11	1	0.01
5	Lymphangitis	98	8,000	1	0	0	0	5	37	40	10	0.08
	Same 1 day later	98	6,000	1	1	0	0	5	50	34	9	0.08

T=average temperature

B=bacillæmia

S=stiff cells

L=lymphocytes

W B C.=total leucocyte count

My=myelocytes

A=adult polymorphonuclear neutrophils

Mo=monocytes

E=eosinophiles

J=juvéniles

Tt=toxic index

¹Here as throughout this paper the term surgical infection denotes a localized collection of pus or other purulent or infective condition in which operative surgical interference is indicated, either to evacuate the pus or to remove the cause of the infection.

true is shown from a study of the 11 cases presented in Table III

CASES 6 to 9 indicate that the hæmogram may be abnormal in malignant conditions either when receiving roentgen therapy or as an antemortem phenomenon. Cases 6 and 7 received roentgen therapy and Cases 8 and 9 represent 3 cases of carcinoma 1 of the breast and 1 of the stomach. Despite the lack of marked infection or of terminal bronchopneumonia both cases present marked antemortem shifts. In Case 8 bone marrow metastases may have been a factor in the production of the shift as is indicated by the presence of 3 per cent unclotted erythrocytes. The bones were not examined at necropsy. Case 10 is the one outstanding example in the entire series in which the hæmogram might have given misleading information. In this instance a perforated ulcer was suspected because of severe pain in a patient under ulcer management. Two days later he passed a stone *per rectum* and recovered. While the hæmogram is abnormal in this case it is not as much so as one would expect with a perforated peptic ulcer. In Case 11 a right sub-diaphragmatic abscess was diagnosed clinically and roentgenologically. However the very slight shift indicated the mildness of the infection and the patient recovered without operation. Again in Case 12 the hæmogram indicates the mild infection in a patient with acute prostatitis. Case 13 represents a man aged 65 with common duct stone and marked jaundice. Only the admission count is given in the table the subsequent course of the toxic index being shown in Figure 2. It is a question as to whether this patient belongs in Table III as while he recovered temporarily without operation the presence or absence of surgical infection is a matter of definition. Operation was performed several months later. Finally Cases 14 and 15 show that as is well known, the hæmogram may be abnormal in so called purely medical conditions. Case 14 represents a patient with ulcerative endocarditis and Streptococcus hemolyticus septicæmia 2 days before death and Case 15 represents a patient who recovered from pneumonia. The similarity in the blood findings in

these 2 cases indicates the difficulty in making a prognosis from the blood findings alone.

In Table IV is shown a definite change in the hæmogram in 10 cases of non fatal surgical infection. A comparison of the toxic indices with those of the cases in Table II, where some of the patients presented just as marked clinical symptoms shows the relatively high indices in the cases with definite surgical infection.

CASES 16 and 17 are examples of acute appendicitis, Case 17 being interesting in that the pre-operative temperature and total leucocyte count were normal despite a pathologically verified very acute appendicitis. In Case 18 the presence of an appendiceal abscess or typhoid fever was suspected the blood findings indicated an abscess and this was found later at operation. Cases 19 and 20 represent

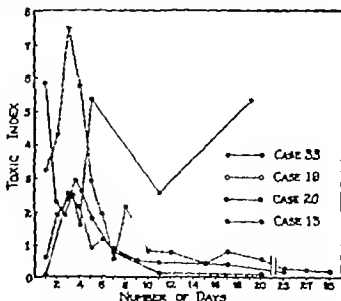


Fig. 2. The variation in the toxic index during the course of surgical infections. The unbroken line represents a fatal case and the broken lines represent 3 cases with recovery.

TABLE III—ABNORMAL HEMOGRAM IN ELEVEN CASES WITHOUT SURGICAL INFECTION

No	Diagnosis	T	W. B. C.	E.	B.	M.y.	J.	S.	A.	L.	Mo.	Ti
6	Carcinoma	100	9,000	4			6	37	4	4	6	93
7	Hodgkin's disease	98	6,000					26	39	6	6	36
8	Carcinoma of breast	93					29	45	5	24	5	5
	Same, day later	95	3,000				6	38	33		6	86
9	Carcinoma of stomach	99	3,000				4	33	4	12	3	63
	Same, day later	90	3,000				6	43	43	7		64
	Same, days later	98	5,000				4	43	34	26	3	3
	Same, 5 days later	100					3	35	34	6		26
	Rectal colic	96	4,000					24	37	6	3	36
	Same, day later	96	16,000					6	39		29	17
	Abscess (?)		3,000	3				7	6	10	7	23
	Same, 5 day later		13,000					9	6	3	6	60
	Acute prostatitis	98	10,000					3	35	34	9	34
3	Cholelithiasis	10	7,000					6	30	6	4	90*
4	Acute endocarditis	1	4,000					47	35	9	3	39
5	Pneumonia	99	1,000				3	39	5		3	503

T = rectal temperature

S = purpura

L = leuk cells

J = lymphocytes

W. B. C. = total leucocytes to count

M.y. = myelocytes

A = adult polymorphonuclear neutrophils

Mo = monocytes

E = eosinophiles

B = basophils

Ti = toxic index

*See Fig. 1 for subnormal course

The patients in Cases 8 and 14 died within 5 days of the last hemogram and the patient in Case 9 within 3 days

children aged 7 and 10 years, respectively with recovery despite an operative finding of perforated appendix with poorly localized peritonitis. The second of these cases is of special interest because of the correlation of the admission toxic index with the operative findings despite a normal temperature and a total leucocyte count of 7,700. In Table IV only the admission data for Cases 19 and 20 are given detailed serial changes in the hemogram being shown in Figure 2. Cases 21 and 22 represent 2 patients with acute appendicitis with recovery the first being gangrenous. Case 23 is an example of a pelvic abscess, all counts being made after the exploratory laparotomy and illustrate the slow convalescence. Two days after the last count recorded, a second abscess was found. In Case 24 the mild course of an abscess is followed. Case 25 represents a patient with an acute exacerbation of chronic osteomyelitis of the tibia vened at operation. Case 26 represents a boy 17 years old with a perforated peptic ulcer that was so indefinite in its clinical symptoms that operation was not performed until 10 hours after admission. It is of interest that the initial smear taken 1 hour after the probable time of perforation showed no definite toxic cytoplasmic granulations while the hemogram already showed a definite change. The next day there were very questionable toxic granulations and the third day a few more distinct toxic changes. This illustrates again for the extreme latency of the cytoplasmic changes. In conclusion it may be said that all of the non-fatal surgical infections shown

in Table IV produced a definite change in the hemogram.

In Table V are presented the changes in the hemogram in 7 cases of fatal surgical infection. These 7 cases all have markedly abnormal hemograms and high toxic indices the average of the highest toxic index being 7.56 whereas the average in the 10 cases with recovery shown in Table IV is 1.61. This would indicate that the toxic index has some value in prognosis as well as diagnosis. However in 2 of the cases of fatal surgical infection the toxic index was never as high as in 3 of the surgical infections with recovery.

The marked infection in a case of postoperative gas bacillus invasion of the abdominal wall is seen in the hemogram of Case 27 taken 30 minutes before death. The previous day the total leucocyte count was 11,000. Case 28 represents a boy aged 3 years with primary pneumococcus peritonitis. The low total leucocyte counts associated with the marked shift are of interest. The polymorphonuclear neutrophils in the peritoneal fluid at the time of death were almost entirely immature forms. Cases 29 and 30 represent patients with friable carcinomas of the rectosigmoid that were perforated at the time of operation with the production of pelvic peritonitis

TABLE IV—ABNORMAL HEMOGRAM IN TEN NON FATAL SURGICAL INFECTIONS

No	Diagnosis	T	R B C	E	B	Mf	J	S	A	L	Mo	TI
10	Appendicitis	90	9,000		0	0	0	31	68	6	5	0.87
17	Appendicitis	97	16,000	0	0	0	0	34	62	10	4	0.84
13	Appendicol abscess	103	16,000		0	0	0	30	48	16	6	0.30
10	Perforated appendix	101	32,000	0	0	3	5	33	30	4	7	3.18*
10	Perforated appendix	99	7,700	0	0	0	1	33	47	18	1	0.6
5	Gangrenous appendix	100	27,000		0	0	0	35	53	7	5	0.74
	Same, 2 days later	100	4,000	0	0	0		18	27	17	16	0.64
	Same 11 days later	90	10,000	3	0	0	0	43	43	20	6	0.90
3	Acute appendicitis	100	20,000	0		0	1	38	39	3	3	1.08
	Same, 4 days later	1		0			1	37	34	14	4	0.47
3	Pelvic abscess	100		0			0	36	43	24	8	.74
	Same, 2 days later	108	14,000	0	0		1	40	47	14	8	0.16
	Same, 4 days later	99	18,000	3	0		0	3	58	18	8	0.14
	Same, 2 days later	98	17,000		0	0	0	8	34	18	0	0
24	Dental abscess	99	12,000		0	0	0	31	51	11	7	.31
	Same, 3 days later	99	10,000	0	0	0	0	13	57	13	8	0.06
5	Osteomyelitis	95	17,000		1	0	1	24	45	1	8	0.40
	Same, 1 day later	98	1,000	0		0	0	21	51	14	4	0
	Same, 7 days later	98	9,000		1	0	0	1	61	13	2	0.04
26	Perforated ulcer	95	14,000	0			8	3	38	9	9	0.45
	Same, 1 day later	100	14,000	0	0		1	24	37	7	11	.54
	Same, 3 days later	100	12,000	0			0	3	59	13	7	0.33
	Same, 4 days later	99	10,000		0		1	3	54	17	13	0.17
	Same, 11 days later	90			0		1	5	58	27	8	0.04

T=average temperature

B=basophils

S=splR cells

L=lymphocytes

*See Fig. for subsequent course

W B C = total (leucocytes) count

Mf = myelocytes

A = adult polymorphonuclear neutrophils

Mo = monocytes

E=eosinophils

J=juvies

TI=toxic index

and death. The marked difference in the extent of the shift in these 2 cases is interesting. In the first case *Streptococcus viridans* was the prevailing organism and in the second with the higher toxic index *Streptococcus hemolyticus*. Case 31 represents a patient with carcinoma of the rectum treated by combined abdominoperineal resection. The initial rise in the toxic index corresponds to an infection of the perineal wound and the terminal rise to a cysto-uretero-pyelonephritis. Case 32 represents a boy with a brain abscess who died of second ary meningitis a week after the last count was taken. Case 33 represents an adult with a perforated appendix and generalized peritonitis who presented such uncertain symptoms that operation was not performed until twenty four hours after admission. The toxic index of 5.85 given in the table was determined several hours before operation. After a temporary improvement which is reflected in the decrease in the toxic index as shown in Figure 2 the patient developed a subdiaphragmatic abscess and died.

RECAPITULATION

A study of the literature indicates that many of the indices devised to determine the presence and severity of infection cannot suitably be applied to surgical infections. The sedimentation rate of the erythrocytes is too labile a test to be satisfactory. Cytoplasmic toxic granulations follow the onset of an acute infection with a latent period that renders the observation of these changes of little value in acute surgical emergencies. Certain tests such as the guttadiaphot and the McDonagh de terminations have no apparent field of usefulness whatsoever at the present time in acute infections and others such as the leucocyte reaction of D'Amato have not been applied to any of the pyogenic infections either acute or chronic.

TABLE V—ABNORMAL HÆMOGRAM IN SEVEN FATAL SURGICAL INFECTIONS

No	Diagnosis	T	W B C.	E	B	M _y	J	S	A	L	M	Ti
27	Gas infection	3				7	28	5	15	4	9	4.11
28	Peritonitis	10	8,000			20	24	19	7	8		17.74
	Same, day later	1	4,000			23	23			23		7.30
29	Pelvic peritonitis	99	8,000				1	48	23	7	6	26
	Same, day later	80	2,000				4	31	28	1	8	89
	Same, days later	94	20,000				5	45	3	6		49
30	Pelvic peritonitis	66	2,000				24	23		8	4	9.83
	Same, days later	66	9,000			6	1	48	50	6	1	6.29
	Same, 4 days later		15,000			8	8	29	1		4	10.75
	Same, 5 days later		5,000			5	7	41	5	1	1	69
	Same, 6 days later	66	8,000			6		44			6	9.77
	A.M. 7 days later	103	18,000			4	22	44	6			1.77
	P.M. 7 days later	91	1,000			5	28	4	9	4	3	7.76
31	Post op infection	89	1,000					7	78	4	4	7
	Same, day later	98	3,000						83	6	6	69
	Same, 7 days later	94	10,000					25	4	9	1	1
	Same, 8 days later	94	3,000					37	47	7		77
	Same, days later	66	200					23	46	6	5	63
	Same, days later	89	4,000					30	30	9		6.45
	Same, 6 days later	90	8,000					28	26	7	9	95
	Same, 9 days later	90	3,000					29	43	8	6	66
32	Brain abscess	94	17,000					3	77	5	4	47
	Same, day later	66	1,000					22	1	18	3	83
	Same, 6 days later	64	14,000					24	8	28	12	69
	Same, 7 days later	200	21,000				3	4	78	16		24
33	Perforated appendix	141	18,000					64	9	4	3	1.85

T=average temperature

B=leucocytes

L=lymphocytes

W B C.=total leucocyte count

M_y=myelocytes

A=adult polymorphonuclear neutrophils

M=monocytes

E=erythrocytes

J=juveniles

Ti=toxic index

The patient in Case 27 died within 30 minutes of the last hemogram, the patients in Cases 28, 29, and 30 within 24 hours, Case 31 within 1 day and Case 32, 6 days.

*See Fig. for subsequent course.

The total leucocyte count, the conventional differential count and various indices and combinations of the two although of considerable value are often misleading. A study of the nuclear changes in the polymorphonuclear neutrophils gives a useful appraisal of the status of surgical infections. However the Arneth count and its modifications are too complicated and pay too much attention to minute subdivisions that are off the scale of changes present in severe surgical infections.

The Schilling hemogram seems especially adaptable to the diagnosis of surgical infections. A simplification of the hemogram

in the form of the percentage of non filamented polymorphonuclear neutrophils is often of value. To avoid confusion and for the sake of uniformity this percentage should be expressed as that of one hundred leucocytes. When on the other hand the percentage of non filamented cells is expressed in terms of one hundred polymorphonuclear neutrophils, the observer does not have the advantage of information obtained from changes in the other cells of the hemogram.

The Schilling hemogram may be expressed as a single arithmetical figure by using what is defined in this paper as the toxic index.

This index includes most of the factors in the complete hæmogram and its formula was determined after trying many similar formulae. It might have been more accurate if a factor depending on the total leucocyte count were included, but to prevent too great complexity this was omitted. The multiplication factors in the formula were determined arbitrarily and are intended to indicate the relative importance of each cell.

The hæmogram was used in a series of cases that while small in number had the advantage of being consecutive and of considerable variety. The results obtained in this series of cases agree with those reported by other writers in similar cases. It is well known that the hæmogram should be used only as an adjunct to clinical examination. Furthermore an increase in the toxic index is not limited to surgical infections and may occur in toxic states and as an antemortem phenomenon. There may be an increase in carcinomatous cases undergoing roentgen treatment and in any infection irrespective of whether or not surgical interference is indicated. The degree of change is not always indicative of the extent of the infection. The test is apt to be more misleading when used as a prognostic omen than when taken as a diagnostic indication since certain patients may recover after a more marked shift than occurs at any time in other fatal cases.

However, if these factors are all taken into consideration and the hæmogram is used in conjunction with observations of the pulse, temperature, respiration and clinical signs and symptoms it gives confirmatory evidence as to the condition of the patient. In many instances the hæmogram is superior to certain well recognized tests, the most outstanding example being cases of overwhelming peritonitis where the total leucocyte count and the temperature may be both subnormal but the toxic index increased with a reasonable degree of certainty. However, the hæmogram is advantageously more stable than the total leucocyte count under influence of pain and fear.

CONCLUSIONS

1. Of 27 indices of infection studied in the literature the Schilling hæmogram seems best

suited for the study of surgical infections. Most of the factors in the Schilling hæmogram can be expressed as a single arithmetical figure by using what is defined in this paper as the toxic index.

2. An alteration in the hæmogram is not a specific indication of infection or that an infection which is present requires surgical interference nor is the degree of alteration always proportional to the severity of the infection. But when used in its entirety or expressed as the toxic index and when taken in conjunction with clinical and routine laboratory examinations the hæmogram adds definite confirmatory evidence as to the presence and course of surgical infections.

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THE EFFECT OF THE GAMMA RAY OF RADIUM ON WOUND HEALING¹

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THE purpose of this investigation was to determine the effects of γ radiation from radium on the healing of wounds. This problem has been approached previously but in practically every instance the agent used was roentgen radiation. The results reported are conflicting. The discrepancies can probably be explained by the marked variations in the techniques used.

L. Freund worked with humans and animals and found that when fresh wounds were subjected to a therapeutic dosage of γ ray healing was somewhat more rapid than in individuals not treated in such a manner.

Fukase, using rabbits, made incisions 10 centimeters long on the backs of 14 animals and irradiated half of the length of the wound the other half being protected with lead. The dosage was 8H (170 kilovolts) or 400 r. No sutures were used and it was found that in all animals the irradiated half healed by primary intention while the control portion healed by secondary intention.

Buhtz, in studying the effects of γ rays on traumatic inflammation in dogs found that skin wounds exposed to 400 r (170 kilovolts) immediately after incision in 24 hours revealed a better tendency toward healing than the control wounds.

F. Freund in attempting to ascertain the influence of γ radiation on inflammation used the same factors of experiment and same animals as Fukase and corroborated his findings. In the irradiated half the inflammation was considerably less and healing took place more rapidly.

Maximow produced aseptic inflammation by implanting celloidin blocks into the subcutaneous tissue of the abdominal wall of rabbits and studied the effect of soft γ rays at various intervals in the reaction produced. He found that there was considerable depression in the usual reaction on the part of the fibroblasts. They did not multiply at all, or started very late, and often the division was

atypical. The protoplasm and nucleus exhibited pathological hypertrophy and the capacity for collagen formation seemed to be lost. Edema developed in the older connective tissue near the inflamed area and clotted fibrin appeared. The fibroblasts seemed incapable of recovering from their injury for a long time although in 2 months there was little difference from the control. Old connective tissue cells were found unchanged by radiation. No distinctive qualitative changes were found in the leucocytes and polyblasts.

Pohle and his collaborators, using rats, made incisions on the backs of the animals and irradiated half of the incision protecting the other half with lead. The dosage delivered was 1000 r at a single sitting. Two separate wave lengths and filtrations were used but no marked difference could be detected between them (100 kilovolts, 2.0 millimeters aluminum, and 140 kilovolts, 0.25 millimeters copper, 1 millimeter aluminum). One group was treated immediately after incision, a second group 24 hours after and a third group at the 48 hour interval. Sections were removed on the seventh day after operation and upon complete healing of the wounds. In all cases they noted a definite retardation in healing in the irradiated portion although exposure after 24 hours seemed to have the most pronounced inhibitory effect. In a second study they repeated the above experiments, except that in this instance sections were taken at daily intervals of from 1 to 9 days after incision. The factors used were 100 kilovolts, 2.0 millimeters aluminum. The findings were similar to those of the first experiments. In no instance however did this slowing of the healing process interfere with the final formation of a smooth scar.

The differences in reaction obtained by the various authors may be explained by the total dosage given to the wounds. Whereas in one instance small to moderate doses accelerated healing in the other larger doses

definitely depressed it. A second factor which may account for the difference is that different animals were used.

These points were, therefore kept in the foreground when the experiments listed below were undertaken to ascertain the effects of the γ ray of radium rather than that of the α ray on wound cicatrization.

METHOD OF EXPERIMENT

Dogs were chosen as the experimental animal in preference to the rabbits and rats used by other workers for the following reasons. First it is possible to make many more incisions on a dog than on the smaller animals thus enabling one to make more accurate comparisons both as regards the irradiated areas as well as the controls. Second it obviates to a certain extent the necessity of using many animals for single experiments thereby eliminating individual reactions as much as possible.

In all animals certain factors of radiation were constant, the only variables being the dosage and the time interval. A plaque measuring 2.8 centimeters by 1.8 centimeters containing 200 milligrams of radium element was used. The filtration was 1 millimeter of platinum and the distance was 7 millimeters. Before proceeding with the experiments we determined the erythema dose for the dog's skin and found it to average 1,500 milligram hours. This was performed in 5 dogs.

Fifteen dogs were used and were divided into 5 groups of 3 each. In all animals the abdomen was carefully shaved and prepared and under intravenous nembutal anesthesia 10 incisions 3 centimeters each in length were made down to the rectus fascia. Five of these were placed on either side of the abdomen extending from just below the costal margin to the iliac crests. They were equidistant from each other and from the midline so that each opposing incision was in a corresponding site, i.e., symmetrically situated. The wounds were immediately closed with interrupted black silk sutures, which were removed on the fifth day after operation. The wounds on one side of the abdomen were radiated and the corresponding wounds on the other side were used as controls. All incisions with the

exception of the one being irradiated were protected with lead.

Group 1a. Three dogs. Each of five incisions on the left side of the abdomen in each dog was given 50 milligram hours immediately after operation with the plaque described previously. At the end of the third day the highest incision with its control was removed for gross and microscopic examination. The other irradiated incisions together with their controls were removed from above downward on the fifth, ninth, fourteenth and twenty second day respectively.

Group 1b. Three dogs. The same procedure as in the previous group was followed, except that a dosage of 100 milligram hours was delivered to each of five areas immediately after operation.

Group 2a. Three dogs. In this instance the total dosage given immediately after incision to each of five areas was varied. Fifty, 100, 250, 500 and 1000 milligram hours were delivered to the wounds respectively from above downward. The five irradiated incisions together with their controls were removed for section on the seventh day after operation.

Group 2b. Three dogs. The same procedure was used as in the last group except that the incisions were irradiated 24 hours after operation and the wounds as before were removed on the seventh day after operation.

Group 2c. Three dogs. The incisions were irradiated as the two previous groups except that it was done 48 hours after operation.

RESULTS

A general summary of the results will be given for each group instead of for the individual animal, except in those cases in which there was a marked difference in reaction.

Group 1a. In this group both *in situ* and after excision of the wound gross examination revealed an apparently increased healing activity in the irradiated wounds as compared to the controls. This was true regardless of the day the sections were taken. These findings were confirmed on histological examination.

In the sections taken 3 to 5 days after incision the healing process was farther advanced than the non irradiated controls as evidenced by greater and more mature fibroblastic activity and a milder inflammatory reaction. In the sections taken later the irradiated wounds revealed a greater amount of connective tissue. For example, an irradiated section taken on the fifth day was as far advanced in healing as was an average healing wound on the seventh day. In the sections taken 22 days after incision little difference could be detected in the irradiated and non irradiated areas with the possible exception of later and more fibrous and hyalinization in the former (Fig. 1 and Table I).

TABLE I.—GROUP 1a*

Dog	Day	Irradiated incision	Non-irradiated control
1	3	Rapid healing	Average healing
	5	Almost healed	Average healing
	9	Young scar	Healed
	14	Scar	Scar (not mature)
	22	Scar	Scar
2	3	Rapid healing	Average healing
	5	Healed	Average healing
	9	Young scar	Healed
	14	Scar	Scar (not mature)
	22	Scar	Scar
3	3	Rapid healing	Average healing
	5	Almost healed	Average healing
	9	Young scar	Healed
	14	Scar	Scar (not mature)
	22	Scar	Scar

Rapid healing—Many young fibroblasts, inflammatory reaction subsiding, new blood vessel formation.
 Average healing—Inflammatory reaction preponderant, later inflammation subsiding, more fibroblasts and blood vessels.
 Almost healed—Many fibroblasts, early connective tissue formation, still loci of leucocytes.
 Healed—Fewer fibroblasts, connective tissue fibers increased, no leucocytes.
 Young scar—Blood vessels still present, connective tissue preponderant.
 Scar—Much connective tissue, beginning hyalinization.

*Doses 2 by 2.00—Filtration 5 mm. platinum—Distance 7 mm.—Doses—100 milligram hours immediately after incision.

TABLE III.—GROUP 2a*

Dog	Milligram hours	Irradiated incision	Non-irradiated control
7	50	Well healed	Healed
	100	Well healed	Healed
	250	Well healed	Healed
	500	Retarded healing	Healed
	1000	Little evidence of healing	Healed
8	50	Well healed	Healed
	100	Well healed	Healed
	250	Healed	Healed
	500	Retarded healing	Healed
	1000	Little evidence of healing	Healed
9	50	Well healed	Healed
	100	Well healed	Healed
	250	Well healed	Healed
	500	Retarded healing	Healed
	1000	Little evidence of healing	Healed

Well healed—Blood vessels present, very few fibroblasts, connective tissue fibers abundant.
 Retarded healing—Inflammation present, fibroblasts preponderant, few connective tissue fibers.
 Little evidence of healing—Very few fibroblasts, inflammation preponderant, no connective tissue.

*Doses 2 by 2.00—Filtration 5 mm. platinum—Distance 7 mm.—Varying dosages. Wounds irradiated immediately after incision. Sections taken on seventh day after operation.

TABLE II.—GROUP 1b*

Dog	Day	Irradiated incision	Non-irradiated control
4	3	Rapid healing	Average healing
	5	Almost healed	Average healing
	9	Young scar	Healed
	14	Scar	Scar (not mature)
	22	Scar	Scar
5	3	Rapid healing	Average healing
	5	Healed	Average healing
	9	Young scar	Healed
	14	Scar	Scar
	22	Scar	Scar
6	3	Rapid healing	Average healing
	5	Healed	Average healing
	9	Young scar	Healed
	14	Scar	Scar
	22	Scar	Scar

See Table I for description of tissue.

*Doses 2 by 2.00—Filtration 5 mm. platinum—Distance 7 mm.—Doses—100 milligram hours immediately after incision.

Group 1b. In this instance the findings were essentially the same as the previous group (Fig. 1 and Table II).

Group 2a. It was found both grossly and microscopically that with doses up to and including 250 milligram hours, healing was definitely more ad-

vanced in the irradiated areas. With doses of 500 and 1000 milligram hours, there was much less fibroblastic reaction, but more inflammatory reaction and some necrosis in the irradiated areas. Healing was therefore definitely retarded as compared to the incisions treated with smaller doses and to the non-irradiated sections (Fig. 2 Table III).

Group 1b. In this group it was noted that even in the smallest doses the healing process was retarded in the irradiated areas, the degree of retardation varying directly with the increase in dose, it being most marked when greater dosages had been given (Fig. 3). In 2 of the 3 dogs in this group the irradiated incisions were still not healed on the seventh day while the controls were fairly well healed. Hence because of the obvious gross findings, sections were not taken for a histological examination. In this animal it was further found that the irradiated wounds had healed completely by the fourteenth day. Sections of both the irradiated areas and control areas on this day revealed little difference grossly except that the scar in the irradiated wounds was thinner and of finer texture. This observation was confirmed by a microscopic examination in which it was found that there was much less fibrous in the irradiated group (Fig. 4 and Table IV).

Group 2c. In this group there was very little difference in the wounds irradiated with 50 and 100 milligram hours and the non-irradiated incisions. Those wounds irradiated with 250 and 500 milligram hours showed a tremendous new connective tissue

TABLE IV—GROUP 2b*

Dog	Milli-gram hours	Irradiated incision	Non-irradiated control
10	50	Retarded healing	Healed
	100	Retarded healing	Healed
	250	No evidence of healing	Healed
	500	No evidence of healing	Healed
	1000	No evidence of healing	Healed
11	50	No evidence of healing	Healed
	100	Wound open	
	250	No evidence of healing	
	500	Wound open	
	1000	No evidence of healing	
12	50	Retarded healing	Healed
	100	Little evidence of healing	Healed
	250	No evidence of healing	Healed
	500	No evidence of healing	Healed
	1000	No evidence of healing	Healed

Retarded healing—Inflammation predominating; fibroblasts increase; no connective tissue.

Little evidence of healing—Very few fibroblasts, inflammation predominant, slight increase.

No evidence of healing—Marked inflammatory reaction, no fibroblasts, increase.

*Plaque 8 by 1.5 cm.—Filtration: non-platinum—Distance 7 cm.—Varying dosages. Wounds irradiated 48 hours after incision. Sections taken on seventh day after operation.

TABLE V—GROUP 2c*

Dog	Milli-gram hours	Irradiated incision	Non-irradiated incision
13	50	Healed	Healed
	100	Healed	Healed
	250	Almost healed†	Healed
	500	Almost healed†	Healed
	1000	Little evidence of healing	Healed
14	50	Healed	Healed
	100	Healed	Healed
	250	Almost healed†	Healed
	500	Almost healed†	Healed
	1000	Little evidence of healing	Healed
15	50	Healed	Healed
	100	Almost healed	Healed
	250	Almost healed†	Healed
	500	Almost healed†	Healed
	1000	Little evidence of healing	Healed

*Plaque 8 by 1.5 cm.—Filtration: non-platinum—Distance 7 cm.—Varying dosages. Wounds irradiated 48 hours after incision. Sections taken seventh day after operation.

†Marked fibroblastic proliferation, but not as far advanced in healing as controls.



Fig. 1. Group 1a. A, Irradiation wound (50 milligram hours immediately after operation). Section on fifth day after operation. Note increased fibroblastic proliferation in contradistinction to control area B. Group 1b. C, Irradiated wound (100 milligram hours immediately after operation). Section on ninth day after operation. Note older connective tissue in contradistinction to control area D.

formation and rich organization tissue in contrast to the controls, which did not show nearly as much fibroblastic proliferation although they were more advanced in the healing process. In the region of the wounds receiving 1000 milligram hours, healing was incomplete whereas the non irradiated areas were in an advanced state of healing (Fig. 5 Table V).

On examination of the wounds, both grossly and histologically, it was found that those wounds irradiated with small doses immediately after incision showed a definite acceleration in the healing process or a shortening of the so-called "lag period", whereas

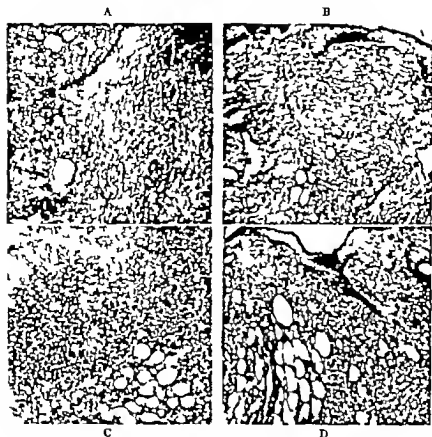


Fig. 1. Group as A, B and C (50, 100, 200 milligram hours, respectively) immediately after incision. Section on seventh day after operation. A and B, Note increased fibroblastic proliferation. C, Note marked inflammatory reaction, necrosis, and absence of healing. D, Control.

those wounds treated with higher doses revealed a definite retardation. This was found to be true however for only those irradiated at the time of incision.

Those wounds irradiated 24 hours after incision showed the most marked deviation from the controls. Healing was definitely depressed and in some cases markedly so after any dosage large or small. These findings correspond with those of Pohle and his associates. However in their work they used a set dosage of 1000 r units with X ray as contrasted with the varying dosages with radium used in these experiments.

In those wounds exposed 48 hours after cutting, it was found that in the smaller dosages, no difference could be detected between the irradiated and non-irradiated sections. It is interesting to note that moderate doses

caused a marked plastic reaction far in excess of that shown in the controls although the latter were more advanced in actual healing. In the higher doses the process was definitely depressed.

Certain other observations which have been made by Pohle and others have also been made in these cases. First, the irradiation had less effect on epithelial growth than it did on deeper tissues. Second it was seen that the superficial layer of the connective tissue was more affected than the deeper layer. This latter is explained on the basis of the absorption law and is true whether the process is proliferative or inhibitory.

A significant finding because of its applicability to the treatment of keloids and hypertrophic scars may be mentioned here. It is briefly this. In those wounds exhibiting a

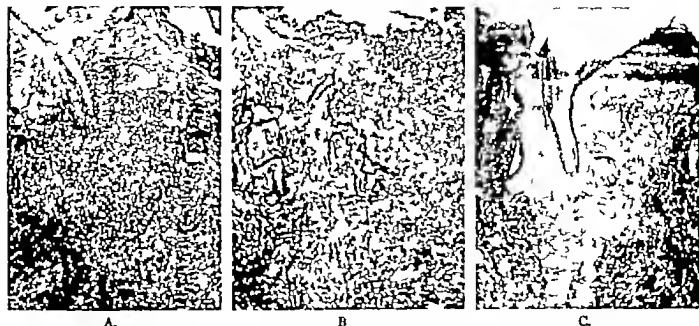


Fig 3 Group 1b A and B (50 and 250 milligram hours, respectively 24 hours after incision) Section seventh day after operation A and B, Note marked inflammatory reaction and absence of healing C, Control

definite delay in cicatrization it was noted that the final scar was as well healed as was the control. Examination revealed a scar of more delicate connective tissue fibers as well as a decrease in the number of fibers and hyalinized structures. These observations have been made by others. It is possible therefore to surmise that in those individuals who show a tendency to hypertrophic scar and keloid formation, treatment should be directed with suitable doses at an optimum time after operation so as to prevent excessive fibroblastic formation as well as the laying down of excess collagen.

It may be assumed from what has been said that when wounds are irradiated immediately after the incision the process follows the Arndt Schultz law, i.e. large doses depress, small doses stimulate. This does not hold, however, when the wounds are exposed to radiation 24 and 48 hours after incision. Several theories have been expounded as to the action of irradiation on the healing mechanism. It may be well to enumerate a few.

Bab believes that the mechanism may be similar to that in the irradiation of malignant growths, namely, that the rays influence tissue containing histamine. This is highly speculative and no evidence is presented in support of it.

F Freund in studying the effects of radiation on inflammation found that X rays inhibit exudation and decrease the number of inflammatory cells. This would then allow for more rapid healing. He stated that in inflammation the inflammatory cells are either evacuated or destroyed by absorption or phagocytosis, or may become transformed into connective tissue cells which bring about healing. The action of the rays may destroy the inflammatory cells more quickly or transform them into connective tissue cells.

L. Freund states that it is a question as to whether the influence is due to the stimulating effects of small doses of X rays on the function and growth of the cells or whether it is to be traced back to the elimination by the rays of an antagonistic factor which delays cicatrization.

Fukase believes that the explanation is in the inhibitory effect of the ray on those leucocytes possessing oxyphilic granules.

The writer is of the opinion that no definite statement can be made regarding this phenomenon as it is difficult to determine if the resultant action is due to depression of the inflammatory process or stimulation of the connective tissue cells or to both in the case of smaller dosage. The reverse process may be true when larger doses are used.

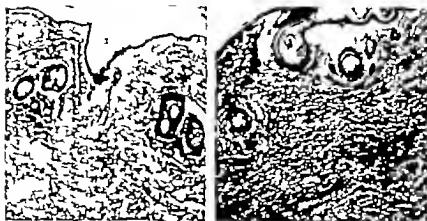


Fig. 4. Group 1b. A, left (150 milligram hours 24 hours after incision). Wound open on seventh day after operation. Section taken sixteenth day after operation. Note fine texture of scar. B Control. Note marked growth of connective tissue.

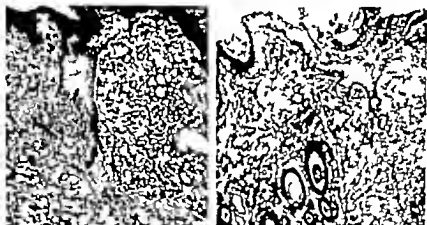


Fig. 5. Group 3c. A, left, 500 milligram hours 48 hours after incision. Note marked fibroblastic proliferation. B Control. Note older connective tissue.

From the evidence accumulated by Maxwell and from observations in these experiments it is believed that in those wounds irradiated immediately after incision the following may be the explanation. In the smaller dosages where acceleration of healing was obtained it is possible that this amount stimulates the tissue itself to the production of a greater and more active group of plastic cells than normally. In larger doses this function is depressed because of injury to the tissue cell and the inflammatory reaction gains the upper hand at the expense of the fibroblasts, thus delaying healing.

Another possibility to be considered in this regard is on the basis of radiation retained by

the tissue itself after it has been irradiated. It is possible that in the case of smaller doses enough radiation is retained by the tissue to stimulate the new cells which are formed to take part in healing. In larger doses the radiation retained is still sufficient to retard the activity of these cells.

In those wounds irradiated 24 hours after incision it is assumed that the precursors of the fibroblasts and the connective tissue cells have already formed. They are undoubtedly in a very embryonic form and hence are extremely sensitive to radiation of any degree thereby causing retardation in the growth of the connective tissue fibers.

In those wounds irradiated 48 hours after

incision the fibroblasts may be old enough not to be affected by small amounts of radiation. In moderate doses they may be stimulated by the rays as is evidenced by the excessive reaction seen in the sections. They are probably not strong enough to withstand larger doses and as a result there is destruction of some of the weaker cells and a retardation in activity of the more vigorous ones.

SUMMARY

1 Wounds produced in 15 dogs were treated with varying dosages of the γ ray of radium at different time intervals with fixed distance and filtration to ascertain the effects of this type of radiation on the healing process.

2 Acceleration of healing was observed in those wounds which were exposed to small and moderate doses immediately after incision. Retardation was noted in those wounds receiving higher doses.

3 Retardation of healing was noted in all wounds exposed to any dose of radiation 24 hours after incision, the degree varying directly with the dose.

4 When the wounds were subjected to varying doses 48 hours after incision retardation effects were noted by the use of the higher doses and no change was seen with the smaller doses.

5 The retardation in healing did not interfere with the formation of a smooth scar.

The author is highly indebted to Drs. Max Cutler and A. C. Ivy for their suggestions in the preparation of this

TABLE VI—GENERAL SUMMARY OF RESULTS

	No dogs	Milligram hours	Hours post-operative	Effect
a	2	50	0	Hastened
b	1	00		Hastened
a	2	Hastened 50 100, 250	0	
		Retarded 500, 1000		
b	2	50 00 250 500 1000	24	All retarded
c	2	No effect 50 00	48	
		Proliferation 50 500		
		Retarded 000		

paper and to Dr. Otto Saphir for his aid in the interpretation of the microscopical sections.

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CLINICAL SURGERY

FROM THE HARVARD UNIVERSITY DENTAL SCHOOL

DENTAL PROSTHESIS IN RELATION TO FACIAL REPARATIVE SURGERY¹

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REPARATIVE surgery and dental prosthesis have for centuries been used separately and in an unrelated way for the repair of facial defects and deformities arising from accidents, destructive diseases, and congenital cleft palate. But it is only within recent years that the advantages of combining these two methods have been realized. Going back to documents written possibly three thousand years ago by the ancient Hindus, we find complete descriptions of operations for the restoration of missing parts of the nose which are, even today, widely used as standard procedures. And during succeeding centuries, the literature of medicine contains many references to plastic surgery. Artificial replacement of missing parts has likewise been practiced since the early days of the healing art, and it, likewise, has an ancient and honorable tradition. Yet it was not until the World War that the benefits to be derived from co-operation of effort between these two specialties of the restorative art became apparent, and upon this foundation of experience a new field has sprung up the potentialities of which have by no means been fully realized.

Facial deformities resulting from war accidents, disease or what not have always existed and under the living conditions of modern civilization we cannot regard them as likely to diminish in number. Great progress in the methods of treating these conditions has been made since the War but there is still room for further improvement of this service, owing to the part which dentistry can play in helping to solve the complicated problem.

Much facial restorative work today is being done by general surgeons because, as a rule, oral surgeons have not essayed the treatment of extensive and complicated facial deformities. This means, of course, that most of the reconstructive surgery of the face is being done by men who are often unaware of the aid to be derived from dental prosthesis. Unless the surgeon himself happens to be dentally trained a rare coincidence, the desirability of securing co-operation from some competent dentist becomes, therefore, apparent. To point out what dental prosthesis can contribute in the correction of deformities of the face and jaws is my purpose in this paper.

CLASSIFICATION OF CASES

The cases to be considered fall readily into three groups, classified on the basis of their genesis as follows: traumata, destructive diseases, and congenital defects and deformities. Under traumata are grouped the fractures of the maxilla, mandible, nasal and malar bones arising from automobile accidents, athletic games, etc.; lacerations of the soft tissues which generally accompany fractures and occasionally result from burns, bruises, or superficial injuries and gunshot wounds. Under destructive diseases are included deformities resulting from treatment of the new-growths: osteomyelitis, lupus, and leprosy. Under congenital defects are included cleft palate and harelip.



Fig. Case 1

¹Read before the Dental Section of the American Association for the Advancement of Science, meeting of the American College of Dentists, Atlantic City, December 26, 1932.



Fig 2. Case 1

The advantages of dental prosthesis in relation to the treatment, surgical, prosthetic or both, of the conditions mentioned may be summarized as follows. In the treatment of traumatism, the prosthetic appliance can be used most successfully for the immobilization of fractures to prevent adhesions and cicatrization resulting from face injuries and lacerations, and to restore the bony framework of the face where missing. In treating destructive diseases, such as cancer and lupus prosthesis is valuable to restore missing noses, orbits ears, and other tissues which have been lost through disease or the radical treatment of it, and also to provide support for tissue grafts in plastic surgery. In treating congenital cleft palate the appliance will improve speech and restore the contour of the face if the maxilla is underdeveloped, as is often the case.

DETAILED CONSIDERATIONS

In the field of fractured jaws, the gradual development from crude beginnings to the more precise and refined methods of immobilization of today has resulted in splints that are far superior to what the general surgeon has ever known. Thus today this branch of traumatic surgery is generally entrusted exclusively to the oral surgeon. Formerly when treating fractured jaws, the general surgeon resorted to external bandaging or in the more severe cases to open reduction of the fracture. These methods, while efficient enough for some cases, have proved to be inadequate in more complicated ones, and again the importance of the occlusal relationship of the teeth was very often neglected thereby inhibit



Fig 4. Case 1

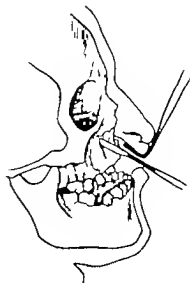


Fig 3. Case 1

ing their normal use in mastication.

Dental methods of fixation of fractures are based upon the following principles. Splints are designed to use existing teeth and alveolar processes as points of anchorage and to re-establish the normal occlusion of the teeth as the fundamental point in the process of immobilization. It is true that the methods of utilizing teeth by ligation have been practiced since the time of Hippocrates in the fifth century before Christ, but it remained for the dentist to recognize the great possibilities of the procedure and to devise various types of splints for specific purposes. Prosthetic dentistry contributed to this development, for before the discovery of vulcanite metal splints were used as early as 1780 by Chopert and Desault. From



Fig 5. Case 1



Fig 6 Case 2



Fig 7 Case 2

orthodontia, however have come more simple and efficient methods of fixation of fractures by means of retention bands and maxillary wires. In mentioning the importance of dental technical methods in the treatment of fractured jaws, it is not my intention to minimize the contributions of surgery. The modern treatment of such injuries has grown up in reality from the accumulated knowledge of both dentist and surgeon.

In many cases of tissue injuries to the face and mouth prosthetic appliances, if adjusted immediately after the accident or operation will forestall adhesions and prevent the contractions that result from the formation of cicatricial tissue, thus assisting to restore the normal contour of the face. Claude Martin was probably the first person to devise ingenious appliances and adjust them immediately after operations for the treat-

ment of disease and accidents in the mouth. While I consider his appliances too complicated in construction and not suitable to our present methods of surgical technique, yet I have followed for many years his principle of immediate insertion of prosthesis, and generally with very satisfactory results. Unfortunately either from lack of facilities or from a scarcity of trained men, this procedure is not followed universally, but I can recommend it heartily.

As has been pointed out before prosthesis can materially assist in the problem of restoring missing noses, orbits, ears, and the bony framework of the face and jaws, where they have been lost through destructive diseases, serious accidents and especially gunshot wounds. In this connection the far reaching results of malignant disease are greatly to be feared. The stubborn and progressive nature of carcinoma is familiar to all, and it is unfortunately true that at present our only positive means of combating this dread disease is based upon a mode of treatment that results in still greater destruction of tissue.



Fig 8 Case 3



Fig 9 Case 3



Fig 10 Case 3



Fig 11 Case 3

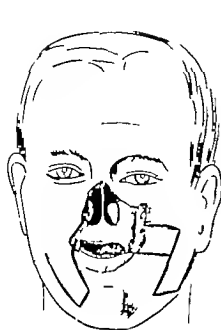


Fig 10. Case 3

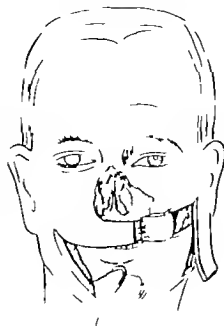


Fig 11. Case 3

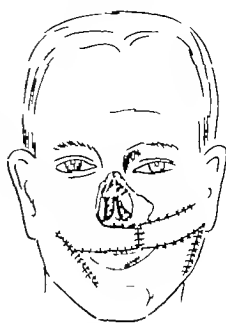


Fig 12. Case 3.

Following the successful treatment of carcinoma, many problems associated with the efforts to repair and restore are encountered. First of all is the problem of supplying new tissue and possibly underlying support. Second most of these patients are past middle age and on account of a reduced vitality are unable to meet the strain of repeated operations. Third a permanent cure is never assured. Fourth patients may reside many hundreds of miles from a center of treatment and lack the means necessary for transportation and hospitalization. A surgeon facing these handicaps is generally obliged to follow the course most compatible with the circumstances.

The treatment of these deformities must be either by surgery or prosthesis, or in some instances, a combination of both. In general, the loss of soft tissues of the face, such as eyelids, lip, cheeks, or part of the nose, may be treated by plastic surgery while massive destruction of the maxilla and mandible, and often the total destruction of the nose, are best corrected by prosthetic means, possibly aided by various operations to fit the individual case.

Artificial noses are constructed of vulcanite rubber. I consider this material well suited for the purpose. Great care should be exercised in molding the shape of the nose bearing in mind that it must harmonize with the contour of the surround-

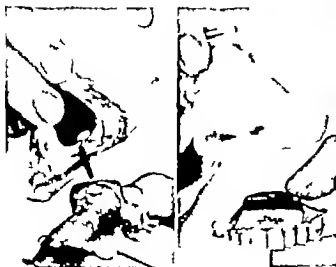


Fig 15. Case 3



Fig 16. Case 3



Fig. 7 Case 4



Fig. 20 Case 4



ing tissues. The firm retention of the appliance to the face is most important for the comfort and peace of mind of the patient as well as for appearances. To give maximum retention the following methods, either singly or in combination may be utilized. The base of the artificial nose should rest upon as much tissue as is compatible with its form. There should be a horizontal extension from the base of the appliance to the floor of the nose; this will prevent it from sliding downward. Spectacles are quite frequently used for retention purposes. The bridge and nasal sides of spectacles should fit accurately to the nose in a definite groove, and their greatest pressure should be at the lowest point of contact half way down the side of the appliance. If there is a perforation of the palate to the nasal floor, an attachment should be provided to connect the artificial nose to the

upper denture. This feature combined with the use of spectacles and a good fitting base will secure the maximum retention.

Cancers of the upper jaw, hard palate and maxillary sinuses are usually more responsive to treatment than those of the soft palate, tonsils, tongue and lower jaw. The most accepted method consists of liberal excision of the cancerous tissue, supplemented by radiation. This naturally results in defects of the palate and maxillary bones, ranging from small perforations to a total destruction of the hard palate and it may also be combined with the loss of surrounding soft tissues. In such cases, surgical repair is totally dependent upon artificial restoration for its success. Such restorations have three main functions: they cover the palatal defect, enabling the patient to speak and to take nor-

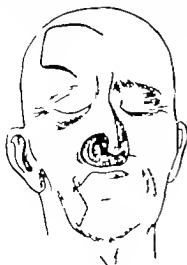


Fig. 18 Case 4



Fig. 9 Case 4

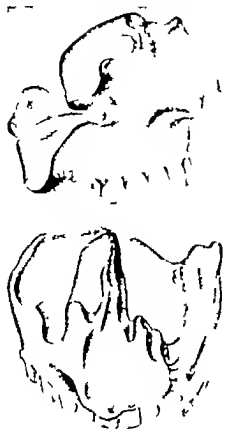


Fig 21 Case 4

mal nourishment they act as a support to the soft tissues in the absence of bony framework, and they prevent adhesions and cicatrization as previously referred to

Gross deformities of the mandible characterized by a definite loss of continuity of the mandibular arch, generally result from osteomyelitis followed by necrosis, trauma including gunshot wounds, or operations for neoplastic diseases. The type of deformity varies a great deal depending upon the amount of bony tissue destroyed, the presence of sound teeth, the condition of the soft tissues and the presence of adherent scars causing distortion of the remaining part of the mandible. In treating such cases, our aim is to restore mandibular function for mastication and to minimize the external deformity

The ideal method of treatment would be to transplant bone in order to fill the gap and restore continuity. This is possible only in cases in which there is only a moderate amount of bony tissue missing. In cases which are not suitable for bone grafting, we are obliged to resort to prosthesis. We must remember that the break in continuity of the mandibular arch should not imply complete loss of function. If we are able to retain the isolated segment of the mandible by a suitable device so that the remaining upper and lower



Fig 22 Case 4.

teeth occlude, we can establish a fair degree of masticating power even though part of the bone is missing. Certain types of appliances are designed merely to hold the remaining part in normal position, and they are correctly called retention appliances. In such cases no attempt is made to correct the external deformity if one is present.

Another type of appliance not only keeps the remaining part of the mandible in its normal position, but also gives fullness to the side of the face where the section of the mandible has been removed. These appliances are truly called artificial jaws as they resemble the missing part of the bone, both in contour and shape. They have limited uses, however, in that they are only practical in patients who have been submitted to resections of the jaw for non malignant tumors.

The artificial restoration of orbits can be satisfactorily accomplished, as is exemplified among the appended cases. Such an appliance requires a considerable amount of technical skill to construct, but judging from the results we have obtained in the clinics of the Harvard Dental School, it can adequately be handled by a skilled prosthodontist, whether or not he may have had any surgical training. Certain advantages in the use of prosthesis for the restoration of orbits, noses, and ears are extremely important. In cases in which the defect has resulted from the radical treatment of malignancies, it is urgent to keep the adjacent tissues under observation for a considerable period of time in order to discover recurrences. With prosthesis as the basis of restoration, this is much simplified and in the case of restoring noses, it is generally much to be preferred to plastic surgery.

Congenital cleft palate cases have been treated for many generations by both surgery and pros-



Fig 23 Case 5

Fig 24 Case 5

theses. Authentic records of the use of prosthetic appliances for defects of the palate resulting from lues and gunshot wounds date back to Ambrose Paré in 1541 followed by Jacques Gullemeau fifty years later. Pierre Fauchard in 1728 and many others since. Undoubtedly the discovery by Goodyear in 1855 of vulcanite rubber as a base for dentures and other improvements in the field of prosthetic dentistry served to stimulate further development of appliances for the treatment of cleft palate. Kingsley gives credit to Snell of London for conceiving the idea of constructing an appliance for this type of defect in 1868. Early

efforts were somewhat crude as to construction, but the principles laid down by Snell, Sueresson, Kingsley, Case and others were sound, and what ever changes came later dealt with details of construction rather than fundamentals.

It is an odd coincidence that the first cleft palate operation was performed by a dentist, a Frenchman named Le Blannier in 1764 but no importance was attached to it until 1835 when Roux of Paris and John Warren of Boston independently re introduced it into the field of surgery. As we all know there was considerable discussion at one time in the dental literature

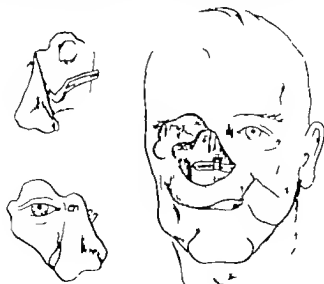


Fig 5 Case 5



Fig. 26. Case 5

about the value of surgery for the treatment of cleft palate as contrasted with artificial appliances. Fifty years ago Kingsley indignantly said 'although the practice has been tested in thousands of cases by the most eminent surgeons of their time it has resulted in such a uniformity of failure considered as a beneficial operation that it should have been utterly abandoned long ago. Later Calvin Case and other prosthetic men voiced the same sentiment only with less severity. Much progress has been made however in cleft palate surgery since Kingsley's time. Today we consider the present technique of great value, and it is almost universal to give every cleft palate child the benefit of operative treatment.

Formerly the surgeon was satisfied if the child presented good operative results. The literature on this subject mainly discussed various operative methods and gives pictures of the child before and after operation. Very little was written however on the subsequent developmental changes. Now we are not satisfied with the immediate operative result alone. It is the surgeon's duty to keep the patient under constant observation until adult age. Speech defects are quite common and require training.

To the dentist, however, congenital cleft palate is significant for other reasons than from the standpoint of the deformity itself. He is particularly interested in the effect which this condition has on the teeth and general oral health. Almost invariably malocclusion is present, because the cleft produces an insufficiency of masticating surface, leading to the underdevelopment of the maxilla. The dentist regards malocclusion as a serious problem largely because he recognizes interference with proper growth and development of the jaws and teeth to be an important factor in the incidence of dental disease.

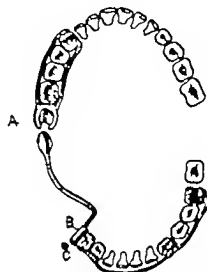
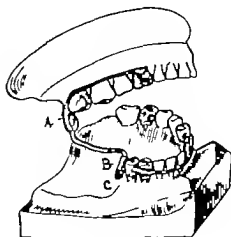


Fig. 27. Case 6

Steps to correct irregularities of the teeth and to expand the maxillary arch must generally be taken by means of orthodontic appliances for cases of congenital cleft palate, following surgical treatment, and excellent results can frequently be obtained. The orthodontist is particularly trained to undertake this work, and he can contribute a great deal to the alleviation of the deficiency. Often this can be achieved by relatively simple orthodontic means, yet also more extensive measures must be occasionally employed. In complicated cases, in which the maxillary teeth are badly misplaced, we have found it necessary to extract some of these teeth, leaving as many as necessary to provide the foundation for a dental plate which not only covers the deformity but also affords a pleasing appearance in the anterior part of the mouth.

In view of the modern advances in the operative treatment of cleft palate cases, one might think that the construction of artificial palates and obturators might soon become a lost art. This is



Fig. 23 Case 7

not so. It is true that obturators are made less frequently but there are still many patients who arrive at adult life without benefit of surgery and whose appliances may have to be, from time to time renewed. Moreover not all operations are successful, and the construction of appliances for such patients often presents more complex mechanical problems than for those who have had no operative treatment. Thus the use of prosthesis for congenital cleft palate cases will probably never disappear.

CONCLUSIONS

In the foregoing sections, I have attempted to emphasize the need for co-operative effort between medicine and dentistry in the restoration of facial deformities, and particularly to call to the attention of the surgeons, who are most frequently called upon to handle such cases, the benefits available in the dental field. For the type of work which I am constantly facing this point has been brought home most forcibly to me. It is too much to ask, nor is it at present necessary or desirable, that the dentist or the surgeon be skilled in the other's field. But there is nothing to prevent either from being informed of it, and my great hope is that a real unity of effort will be achieved in the near future—a unity which will bring increased benefits to the patient whose welfare is fundamentally our principal objective.

CASE REPORTS

CASE 1: R. M. aged 9 years. This patient had been operated upon for repair of the palate in early childhood. He had probably one of the most extensive types of adult cleft palate deformities (Fig. 1). Local examination showed the nose distorted toward the right side, due to the deviation of the nasal bones, as well as the displacement of septal and lower lateral cartilage. The upper half of the face including the lip, was markedly retracted, while the lower part of the face looked unduly prominent. The upper

teeth were poorly developed and scattered over the palate (Fig. 2). The hard palate had lost its normal contour and was covered mostly by scar tissue, while the soft palate had no uvula and was poorly formed and short. His speech, however, was fair. The treatment of the case involved many interesting points. The following were the most important: (1) correction of the nasal deformity and impaired breathing, (2) correction of the retraction of the upper lip, (3) the reconstruction of the patient's dental apparatus.

Operation, May 17, 1930, Massachusetts Eye and Ear Infirmary. General anesthesia was used. First, submucous resection of the septum was done. Second, all the teeth of the upper jaw in malposition were extracted, only the molars and bicuspids being left. No effort was made at this time to correct the deformity of the lower part of the nose. In order to correct the retraction of the upper lip it was necessary to free the base of the lip from adhesions and introduce a prosthetic appliance to retain the contour of the lip in its normal position. This temporary appliance was prepared following the first operation.

Operation, July 17, 1930, Massachusetts Eye and Ear Infirmary. General anesthesia was used. First, a wide incision was made along the buccal fold under the upper lip and, with a blunt instrument, the soft tissues under the nose and the sides of the nose were freely separated from the periosteum (Fig. 3). Second, dental composition was added to the buccal rim of the temporary denture and fitted to the raw area under the lip. Third, a sufficient amount of skin graft was taken from the thigh and pressed firmly against the denuded area, the denture being used as a splint. Fourth, the lip was then repaired by closing the scars and making a better approximation of the uneven borders. The appliance was not disturbed for a few days. By this time the skin graft within the buccal cavity had taken and there was a good space under the upper lip and side of the cheek for a permanent prosthetic restoration. He was discharged from the hospital on July 3, 1930.

October 22, 1930. The third and last operation was performed for the correction of the nasal deformity. It was necessary (1) to correct the nasal deviation, (2) to shorten the nose, (3) to raise the tip, and (4) to correct the dissymmetry of the nostril.

Following his discharge from the hospital a permanent denture was made (Figs. 4 and 5).

CASE 2: F. R. This patient reported at the Huntington Memorial Hospital in May, 1930, for advice on a lesion of her nose. Examination showed an ulcerated lesion involving the medial third of the upper lip and borders of the nose. The lower part of the nose and part of the upper lip were destroyed. She was admitted to the hospital.

On June 13, the patient was operated upon for removal of the carcinoma which involved excision of the greater part of the nose, cartilage and septum, and the upper lip. Partial repair of the upper lip was done by utilizing the remaining part on the right side and part of the lower lip on the left.

Two more operations were performed for further plastic repair. In the first operation, the lip was reformed by joining the two flaps and enlarging the mouth by incisions at the right and left angles, while in the second, the borders of the nose were prepared for a better adaptation to an artificial appliance.

Following the patient's discharge from the hospital she reported to the Harvard Dental School where an artificial nose was constructed under the author's direction. She was discharged on October 7, 1930 (Figs. 6 and 7).

CASE 3: A. C. A. This patient was admitted to the Massachusetts General Hospital on April 6, 1930, for carcinoma of the face. The disease had its origin 5 years



Fig 29 Case 7

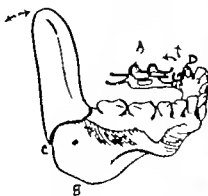


Fig 30 Case 7



Fig 31 Case 7

previously starting as a small pimple on the left side of the upper lip. It was diagnosed at that time as lupus. Numerous treatments of X ray sun, carbon dioxide and caustics were given, but in spite of these treatments, the lesion had continued to grow. Its entire progress had been painless. Aside from the local lesion, the patient was in excellent health. Examination on admission to the hospital showed a large ulcerated mass covering the greater part of the nose and upper lip invading the hard palate as well as the internal structure of the nose. The biopsy report was "basal cell carcinoma" (Fig. 8).

On April 23 the patient was operated upon under general anesthesia. A wide excision of the cancerous tissue was made by electrocoagulation. Four front teeth were removed as well as the anterior processes and the greater part of the septum of the nose. The entire area was debrided with electrocoagulation. The wound was left wide open (Fig. 9).

While the wound was gradually healing, plans were made for the repair of the lip and nose. The following plan was adopted: (1) to perform a plastic operation and repair the upper lip; (2) to restore the nose with prosthesis.

In the next operation the upper lip was repaired by taking a rectangular flap from the right side of the lower lip. This flap included skin as well as mucous membrane. On the left side, the skin of the cheek and side of the face were utilized as seen in the diagrams (Figs. 10, 11, 12). Later the external perforation of the nostril (as seen in Fig. 13) was closed by undermining the skin tissue of the lower eyelid and side of the face, and bringing it forward to the border of the nasal outline. Previous to the operation on the lip a temporary denture was made in order to retain its proper contour (Fig. 14).

Following the plastic operation a dental and nasal prosthesis of vulcanized rubber was made at the Harvard Dental School. This consisted of an upper denture held in position by clasps. A stout square wire was attached to the anterior part of the denture so as to protrude behind the upper lip into the nasal cavity. An artificial nose was made with an attachment of a square tube at its inner surface to fit on the attachment of the denture (Fig. 15).

Rhinoplasty was seriously considered in this case and in fact preliminary steps were taken by preparing a forehead flap but owing to the uncertainty of a possible recurrence of the disease, it was decided to have the patient continue with the prosthesis, as this method gives a better chance for observation (Fig. 16).

CASE 4 W. G. aged 56 years. This patient was operated upon by Dr. Charles Lund in March, 1919, for adenocarcinoma of the right maxillary sinus, palate, and upper lip. Examination (Fig. 17) showed that the patient had lost part of the right side of the nose, upper lip, and the anterior third of the palate. The mouth was edentulous, and there was an old un-united fracture on the right side of the lower jaw. The wound was free from any suspicion of malignant disease. At this time a vulcanite plate was made to fit over the upper jaw. Prior to plastic operations for the repair of the lip, a temporary upper denture was made which was retained by a finger like projection of the vulcanite toward the floor of the nose.

Seven operations were performed under local anesthesia extending from April 28, 1919, to January 25, 1920. The lip was repaired first by utilizing the remaining part of the upper lip on the left side, and second by taking a rectangular flap from the right side of the lower lip using the full thickness of the cheek (Figs. 18 and 19). For the repair of the nose, a skin graft was introduced to the under surface of a forehead flap; this flap was later brought down to close the nasal defect (Fig. 20).

After leaving the hospital a new dental plate was constructed to fit the patient's upper jaw thus making it possible for him to talk distinctly. This appliance as you will see, is held in position by contact with the nasal tissues posteriorly and with the lips anteriorly (Figs. 21, 22).

CASE 5 A. B. This patient reported in 1928 for reparative treatment. His past history dates back to July, 1918, when a small wart-like growth appeared on the nose. In looking over the history I found that he had radiation as well as operative treatment at various times. The last operation was performed in May, 1928, at the Huntington Memorial Hospital. Examination showed destruction of the right eye and orbital contents, the entire nose, upper lip, and entire hard palate with the exception of the region supporting the left upper third molar tooth. The soft palate was intact, and there was no evidence of a recurrence at the time of examination (Fig. 23).

The plan adopted for reparative treatment consisted of the following steps: (1) plastic operations for the replacement of the upper lip; (2) construction of an upper denture to cover the palatal vault and to support the upper lip as well as the nasal and orbital prosthesis; (3) to restore the nose, orbit, and side of the face with prosthesis.

An attempt was made to utilize the tissues on the right side of the face but I failed, possibly due to the fact that

he had had extensive radium treatment. Subsequently a tube flap was made on the side of the neck which was gradually transferred to the face as seen in (Fig. 24). The prosthetic appliance consisted of an upper denture with a clasp encircling the upper left molar and a projection of the denture extending over the border of the soft palate. On the nasal side of the denture, two parallel tubes were inserted on a hinged, critical bar to receive a fork connected with the facial prosthesis. The facial prosthesis as seen in Figure 25 consisted of a combined nose, eye, and side of the face. In addition to the forked attachment mentioned in connection with the dental plate, spectacles were used to hold the prosthesis in position (Fig. 26).

Unfortunately the patient suffered a recurrence of the malignant disease, but he was able to use the appliance with considerable comfort for a long time.

CASE 6. Mrs. C. This patient was operated upon for adamantinoma of the mandible by Dr. Channing Simmons, in 1930. After the tumor of the mandible was healed she was referred to me for prosthetic restoration.

My examination showed that the right ramus and part of the body of the mandible were missing. While the patient was able to bring the remaining teeth of the mandible into good occlusion, the necessary power for mastication was lacking.

As seen from the diagram (Fig. 27) gold crowns were made for the right upper first bicuspid and second molar teeth, and connected with buccal and palatal wires. At the distal end of the molar crown an extension socket was made, *E*. The lower appliance consisted of a series of crowns over the teeth. A tube was soldered to the distal side of the right lower bicuspid crown, *B*. The connecting link for the upper and lower appliance was made of box *y* gold wire, the distal end of which fitted into the groove above, while the lower end was bent at right angles and fitted into the tube below. This was prevented from slipping by a small threaded nut attached to the threaded wire, *C*.

This appliance allowed enough freedom for the latral motion of the mandible, and at the same time, prevented the mandible from swinging backward. Soon after the appliance was cemented over the teeth, the patient was able to control the mandible more effectively and acquired greater power of mastication.

CASE 7. L. M. aged 6 years. This patient suffered from rapidly growing tumor of the right side of the mandible (Fig. 28). She gave a history of an operation in January, 03, for cyst of the jaw, and another one in

April, 1931. In August, she was given radium treatment of approximately 4000 millcurie hours but the tumor continued to grow and she was admitted to the Massachusetts General Hospital in December, 1931. Examination at this time showed a large, apparently encapsulated, hard mass involving the right side of the mandible and extending into the temporal fossa. The general condition of the patient was good.

The patient was operated upon at the Massachusetts General Hospital, removing the entire mass (Fig. 29). After the first 3 weeks during which she was on the danger list, her convalescence was fairly rapid. A few days following the operation, a temporary artificial jaw extending from the temporomandibular joint to the existing teeth on the left side, was introduced in order to keep the normal contour of the face as well as to hold the remaining part of the mandible in its proper position. After she was discharged from the hospital, she reported to the Harvard Dental School where a permanent artificial denture was made under the author's direction.

As seen from the diagram (Fig. 30) the appliance consists of two main sections: first a series of crib clasps fitted over the selected teeth on the left side, *I*; second, a maxillary plate more or less shaped to the contour of the mandibular bone designed to replace the missing segment, *B*. There are two hinged joints, one at the angle of the artificial ramus, *C*, the other at the junction of the clasps and maxillary plate, *D*. The purpose of these joints is to give more flexibility to the apparatus and to prevent undue strain on the teeth that are carrying the clasps.

The appliance when first introduced into the mouth, rested upon the raw surfaces of the buccal cavity but epithelial tissues gradually grew under the appliance. The ideal method would be to do a skin grafting to cover the raw surfaces but for various reasons this has not as yet been done.

The macroscopic examination of the tumor showed small round cell sarcoma. Up to the present time, however, there has been no evidence of recurrence although the pathological picture does not give much hope for a final cure (Fig. 31).

Since this paper was written, the patient has unfortunately had a recurrence of the malignancy in the scalp and later in the naso-pharynx. Extensive X-ray therapy does not seem to have had any alleviating effects. The patient was able to use the prosthetic appliance described above comfortably for 3 years. The final diagnosis was endothelioma.

IRRADIATION OF THE PARATHYROIDS IN GENERALIZED OSTEITIS FIBROSIS CYSTICA¹

REPORT OF A CASE

MAX CUTLER M.D. AND STUART F. OWEN PH.D. CHICAGO

THE relationship between generalized cystic disease of the skeletal system and hyperfunction of the parathyroid glands has received much attention in the recent medical literature. The experimental production of the disease in animals by the injection of parathormone, the recovery of patients suffering from multiple cystic bone lesions after parathyroidectomy and the frequent association of the characteristic bone lesions with hypercalcemia and parathyroid tumors leave little doubt as to the etiological relationship between hyperfunction of the parathyroid glands and generalized osteitis fibrosis cystica. In 1932 Hellstrom found 32 cases in the literature in which parathyroidectomy had been performed for this state and added one case of his own. Further reports have appeared since this publication.

The purpose of this communication is first to present the clinical result in a case of generalized osteitis fibrosis cystica treated by radiation of the parathyroid glands and, second, to suggest the possible value of radiation as an aid in determining which of the parathyroid glands is responsible for all or the greater part of the hyperfunction.

That radiation treatment of the affected bones has had a beneficial effect upon generalized osteitis fibrosis has been recorded in the literature. Thus Rappaport has reported the case of a young woman aged 28 years. The disease which was generalized had been present 8 years with relapses and remissions. There had been spontaneous fractures. Biopsy of one of the cysts in the tibia showed the histological structure of giant cell tumor. A prolonged course of calcium therapy by mouth and roentgen-ray therapy to the diseased bones extending over a period of 18 months resulted in marked clinical improvement and roentgen examination of the bones showed an increased calcium content in the cystic areas. A patient reported by Schneyer received extensive roentgen-ray therapy to the skeletal lesions and showed marked clinical improvement. The pains disappeared and calcification of the cystic lesions was noted on X-ray examination. A case reported by Gerlach in which intensive roentgen ray therapy was administered to the diseased bones under an erroneous clinical diagnosis of sarcoma proved at autopsy to be generalized osteitis fibrosis cystica.

The irradiated bones showed transformation of the fibrous bone marrow to a solid tissue which exhibited no signs of new bone formation.

Whereas the above observations are examples in which radiation therapy was administered to the affected bones, the present communication is concerned with the effect upon the course of generalized osteitis fibrosis cystica by irradiation of the hyperactive parathyroid glands. A review of the literature indicates only a few recent references upon this phase of the problem.

In 1931 Quick and Hunsberger reported the results of roentgen treatment of a palpable parathyroid tumor in a patient suffering from generalized osteitis fibrosis cystica. The authors state that following removal of the tumor the serum calcium again increased and roentgen irradiation was administered without improvement. They do not state the dosage; consequently it is impossible to interpret the significance of this observation.

In 1932 Hellstrom described the case of a woman aged 54 years whose symptoms began 10 years previously. A tumor of the alveolar process was noted 6 years before admission. Curettage showed a giant cell sarcoma. There was exophthalmus. The basal metabolism was increased and a tumor was present in the region of one parathyroid; the serum calcium was 14 milligrams per 100 cubic centimeters. Roentgen-ray therapy to the parathyroid tumor resulted in a lowering of the basal metabolism, disappearance of the exophthalmus, and a marked clinical improvement. The cystic lesions which were found to be widespread throughout the skeletal system showed healing by calcification. This case is an example of hyperthyroidism and hyperparathyroidism with marked beneficial effect upon the course of the disease following roentgen-ray therapy to the parathyroid tumor. A similar improvement in symptoms following radiation therapy of the parathyroids has been observed by Well (quoted by Mandl).

In a recent observation recorded by Huguet the disease was limited to the right radius which showed a typical cystic lesion. The blood calcium was elevated. Roentgen-ray treatments were administered to the parathyroids and ergosterol was given by mouth in large doses. After eight

¹From the Cancer Research Unit and the Tumor Service, Veterans Administration Facility, Hines, Illinois. Published with the permission of the medical director of the Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the writers.



Fig. 933 Photograph of patient after treatment November

exposures the calcium content of the blood and urine was reduced to normal and the bone lesion showed marked improvement. The ultimate result is not recorded.

In 1932 Merritt reported the case of a white woman, aged 34 years, who in 1918, developed signs of hyperthyroidism for which subtotal thyroidectomy was performed. One year later symptoms of hyperthyroidism recurred and in addition she complained of stiffness in the right knee. On examination the patient was found to be emaciated, the basal metabolic rate was plus 35 per cent. Calcium determinations were not made. The right knee was swollen and roentgenograms showed cyst like areas of bone destruction involving the distal end of the femur. No other bone lesions were discovered. The thyroid and parathyroid areas were irradiated. Three weeks later there was noticeable improvement in the patient's condition. Further treatment was given to the thyroid and parathyroid areas. On subsequent examination roentgen ray studies of the knee showed scarcely a trace of the original bone lesion or of hyperthyroidism. In this patient the bone disease was localized and there is no record of the



Fig. Spine, during treatment January 5, 1933

calcium content of the blood. The clinical result, however, is so striking that the relationship can scarcely be questioned.

CASE REPORT

The patient is a white male, aged 43 years, a farmer by occupation. He was admitted to the Veterans' Administration Facility Hines, Illinois, on September 18, 1932. The family history was negative for tuberculosis, cancer, diabetes, syphilis, and neuropsychiatric diseases. His past history was negative except for an attack of influenza in 1920. In 1930, following repeated attacks of abdominal pain and vomiting, cholecystectomy and appendectomy were performed, resulting in complete relief of these symptoms.

The patient dates his illness to May 1931 at which time there was a gradual onset of general weakness and fatigue on exertion. He found that he could no longer carry on his work. This condition was soon followed by severe pains in the right hip, back, neck, and head, and subsequently the left hip. Two years before admission to this hospital (September 1930) the patient was hospitalized in another institution where a diagnosis of Paget's disease was made. Following his discharge from the hospital he found he could no longer walk and it was necessary to use crutches. He slowly lost control and use of his legs and in June, 1932, was confined to bed.

Examination upon admission resulted in the following findings. The patient was unable to move the lower extremities and complained of a stinging sensation and numbness in both legs. The numbness extended as high as the lower costal margins. He was poorly nourished and the muscles showed a marked hypotonicity. There was diffuse tenderness throughout the entire skeletal system. The reflexes at the knees and ankles were exaggerated. The



Fig 3. Skull, anterior view Before treatment. September 19, 1931

plantar reflexes were normal. Manipulation of the hip joint caused pain, more marked on the right side, but there was no limitation of motion. There was extensive muscular atrophy. The abdomen was somewhat extended but no masses could be palpated. Examination of the spine showed an obliteration of the lumbar lordosis and on palpation an irregularity could be felt over the spinous process of the fourth and fifth dorsal vertebrae. There was marked tenderness upon manipulation of the cervical spine.

Neurological examination showed that the pupils were equal in size and reacted normally to light and accommodation. The abdominal and cremasteric reflexes were sluggish. The deep reflexes of the extremities were slightly exaggerated, but equal on the two sides. There was some disturbance of sensation over the lower extremities however



Fig 4. Skull, anterior view After treatment. July 13, 1933

tactile and tone sensations were not entirely lost. There was marked hypotonia of the lower extremities with marked muscular atrophy apparently more marked on the right side than on the left.

Examination of the X-ray films revealed the following findings. The bones of the skull showed considerable widening between the inner and the outer tables, the usual trabecular structure of the calvarium was replaced by an irregular mottled process. The sella turcica was normal. Examination of the long bones showed them all to be involved, the process being most marked in the femora and tibiae. The changes consisted of widening of the shafts of the bones and obliteration of the trabecular structure,



Fig 5. Skull, lateral view Before treatment. September 19, 1931



Fig 6. Skull, lateral view After treatment. July 13, 1933.

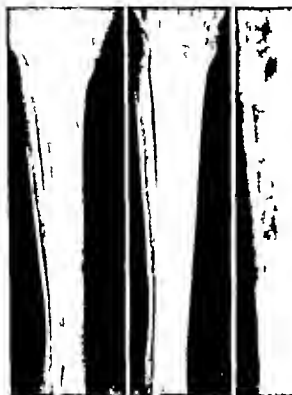


Fig. 7

Fig. 8

Fig. 9

Fig. 7 Tibia, right. During treatment January 5, 1933

Fig. 8 Tibia, right. After treatment September 6, 1933

Fig. 9 Femur, right. Before treatment September 23, 1933



Fig. 10

Fig. 11

Fig. 12

Fig. 10 Femur, right. After treatment September 6, 1933

Fig. 11 Femur, left. Before treatment September 23, 1933

Fig. 12 Femur, left. After treatment July 13, 1933

producing mottled appearance. Scattered throughout the long bones and skull were numerous cystic areas of bone destruction with clear cut borders varying from 1 centimeter to 5 centimeters in diameter. The posterior portions of the ninth and eleventh ribs on the left, and sixth and eleventh ribs on the right were expanded by irregular cystic areas. There were irregular processes in some of the ribs on the right side anteriorly. The dorsal vertebrae showed a diffuse granular osteoporosis of all the vertebral bodies with a complete collapse of the sixth dorsal vertebra. Pelvic examination showed changes similar to those in the spine with numerous sharply circumscribed cystic areas.

On October 1932, roentgen-ray therapy was instituted over the spine and long bones (see Table I) with no clinical improvement.

Examination of the blood calcium on November 3, 1932 showed 59.4 milligrams per 100 cubic centimeters. Benedict-Jones bodies could not be demonstrated in the urine. No tumor could be felt in the thyroid or parathyroid areas. Because of the high blood calcium a diagnosis of hyperparathyroidism and generalized osteitis fibrosa cystica was made and radiation therapy of the parathyroid areas was instituted. Figure 13 indicates the manner in which three fields were irradiated separately and blood calcium determinations made before and after treatment of each field in an effort to determine which parathyroids exhibited the greater hyperfunction.

Figure 14 indicates the blood calcium studies in relation to the time and amount of roentgen ray therapy. The roentgenograms illustrate the striking bone changes following treatment. Comparison of the roentgenograms before and after irradiation of the parathyroids shows a marked regeneration of bone with an increase in density due to deposition of lime salts in the cystic lesions (Figs. 1 to 3). Many of the cystic areas are no longer discernible and the bones have assumed a normal density. It should be noted that in addition to the roentgen therapy the patient received a high vitamin and high calcium diet.

At the present writing there is a marked and steady improvement in the patient's general condition. Two weeks after treatment of the parathyroids he began to regain the normal use of his legs and the paraplegia has now completely disappeared. His strength has increased so that he is able to walk short distances. The pains have diminished in some areas and disappeared in others, the appetite has improved, and there has been a marked improvement in the tonicity of the muscles.

Attention is directed to a series of observations which indicate that radiation of hyperplastic or adenomatous parathyroid glands associated with generalized osteitis fibrosa cystica and hypercalcemia results in a lowering of the blood calcium,

TABLE I.—SHOWING X RAY THERAPY

Date	Röntgen Units	Area Treated
0-18-32 to 1-4-33	340	Thoracic and lumbar spine
1-7-33 to 2-5-33	1861 1003	Right and left parathyroid area sternum
3-23 to 4-16-33	3081	Right and left sternum
4-21-33 to 5-5-33	500	Parathyroid areas and 3 in Fig. 3
5-22-33 to 6-3-33	500	Right parathyroid area Area 1 in Fig. 1
6-13-33 to 6-2-33	900	Left parathyroid area Area 2 in Fig. 1

a calcification of the cystic lesions in bone and a marked clinical improvement in the patient. Similar and more numerous observations are recorded after parathyroidectomy. The ultimate relative value of radiation and surgery as therapeutic methods will depend upon data which further studies must establish. One of these is the question of permanency of results and many of the treated cases are too recent to be of value in this respect.

It should be pointed out that following removal of parathyroid tumors the blood calcium frequently drops below normal and gradually recovers. In some examples the blood calcium returns to the original abnormally high level. It is possible that in these examples the remaining parathyroid glands gradually take over the function of the diseased gland and ultimately may themselves become hyperplastic and thus overactive. Another possibility that suggests itself is that the adenomatous process may not be limited to one parathyroid gland. One of Hellstrom's cases in which parathyroidectomy failed seemed to indicate the possibility that another parathyroid adenoma was present. It should be noted that an inadequate surgical extirpation may lead to a renewed rise in serum calcium as occurred in the case which Quick and Hunsberger have reported in the literature.

Awaiting further and more prolonged observations upon the surgical and radiation treatment of parathyroid tumors the use of radiation suggests itself under several circumstances: (1) when there are contra indications to operation; (2) as a post-operative method when an adenoma is only partially removed; (3) when following removal of one parathyroid adenoma a persistently high serum calcium suggests the possibility of a hyperplasia or adenoma in the gland on the opposite side.

It is further suggested that exposure to radiation of each parathyroid area separately protect

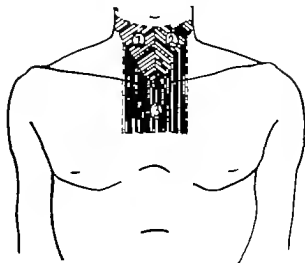


Fig. 13 Showing the areas selectively irradiated. Radiation of areas 1, 2 and 3 at once (500r) gave a blood calcium drop from 16.7 to 14.1 or 2.6 milligrams. Radiation of area 1 alone (500r) gave a blood calcium drop of 17.7 to 16.0 or 1.7 milligrams. Radiation of area 2 alone (500r) gave a blood calcium drop of 18.6 to 15.2 or 3.4 milligrams.

ing the opposite side may constitute a useful method in indicating the site of the adenoma when no tumor can be felt. In our patient a more pronounced lowering of serum calcium occurred on one side than the other. This difference is larger than the percentage of error obtained in the laboratory determination and is therefore, suggestive.

This isolated observation is entirely inadequate to permit any conclusions but it is highly suggestive for these reasons. It has been shown experimentally by Walters, Anson, and Ivy that the exposure of the thyroid and parathyroid areas in normal dogs results in a slight hyperplasia of the parathyroids but no increase in blood calcium. It is also known from clinical experience in which huge doses of radium and X rays are administered over the thyroid and parathyroid areas that the normal parathyroid glands are highly resistant to radiation. Thus for example, exposure of these areas for the treatment of carcinoma of the thyroid and carcinoma of the larynx to tremendous doses of radiation does not cause symptoms of tetany.

From radiophysiological studies of other tissues it is known that normal glandular function is highly resistant to radiation whereas actively hyperplastic cellular tissue is more radiosensitive. From these considerations it would be expected that an adenomatous hyperplastic parathyroid gland should respond to radiation by a diminution of its activity whereas a normal gland would respond only slightly or not at all. The response of

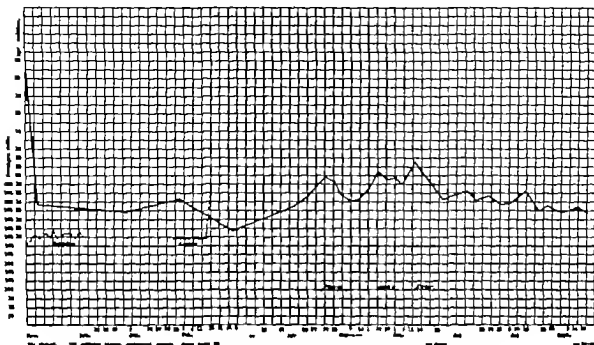


Fig. 14. Blood calcium studies in relation to time and amount of roentgen-ray therapy

hyperthyroidism to small doses of radiation in contradistinction to the radioresistance of the normal thyroid gland constitutes an important analogy.

SUMMARY AND CONCLUSIONS

1. A case of generalized osteitis fibrosis cystica associated with hypercalcemia is reported in which marked clinical improvement took place following treatment by radiation of the parathyroid glands.

2. This observation and others recorded in the literature suggest the use of this method in cases in which surgical operation is contra indicated or in which parathyroidectomy fails to produce a cure.

3. Radiation of each parathyroid area separately is suggested as a possible aid in determining the site of the adenoma before operation a procedure which may render the exploration technically less difficult. Further observations along this line are needed.

4. The relative merits of surgery and radiation as the essential treatment of parathyroid adenoma associated with generalized osteitis fibrosis cystica must await further observations.

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JUXTA-ARTICULAR PARTIAL TIBIAL OSTEOTOMY¹

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THE occurrence at the knee joint of deformities sufficiently severe to require surgical intervention is so commonplace that frequently, no more than casual consideration is accorded them. Simple as they may appear to be, there are many which present real problems in reconstructive surgery, and rather than a facile surgical technique, demand a sound mechanical philosophy, not of the joint alone, but of the leg as a whole. In many cases the traditional use of supracondylar osteotomy has led to satisfactory results, while in others, to the chagrin of the attending surgeon, the outcome has left much to be desired, though the cases were apparently identical. If these cases are more carefully reviewed it will be seen that the good results have been noted in those in which relatively normal relationships have been restored and where, consequently the correction has coincided with the site of the deformity. In the unsuccessful cases, on the contrary, it will be observed that instead of 'correcting' it at its site of occurrence the original angular deformity has been 'compensated' by the development of an opposite angulation. Within the limits to which this compensation has been accurately gauged, the development of a scoliotic or cork screw type of curve may appear to realign the leg beneath its covering of muscles, without, however, obviating the ill effects upon the intervening joints of the stresses and strains to which a leg thus doubly deformed must be subjected.

In those accustomed to locomotion over level ground, it will be observed that the body weight passes approximately through the center of the head of the tibia and that both the superior and inferior articular surfaces of the tibia are approximately perpendicular to the shaft and parallel to each other and the ground (Fig. 1). It must be obvious that a change in any of the component parts of the leg, considered as a column of force transmitting the body weight, must necessarily be associated with the development of correlative signs or symptoms. In the condition of flat feet, the appearance of calf thigh, or back pain as symptoms of strain is common while in the post-operative care of patients in whom a femoral bifurcation has been performed a definite tendency toward knock knee and varus of the foot has been observed. In a quite similar manner, and from whatever cause, any variation beyond the physiological, in the inclination of its articular

surfaces to the shaft of the tibia will determine the appearance either of symptoms or signs directly attributable to that variation. The occurrence of arthritis at the tarsal joint after improperly reduced fractures about the ankle as well as the appearance of symptoms in the knee joint in association with pes varum or valgum are well known. Probably equally well recognized but less commonly alluded to are the deformities of the feet which arise as a result of lateral deformities about the knee joint. In the effort to maintain the foot flat upon the ground in walking, either a pes varus or valgus may be noted, though in general genu valgum tends to be combined with a pes varus while genu varum tends to a pes valgus.

In the lower tibial articulation the importance of maintaining its perpendicular relation to the shaft of the tibia, even if need be at the expense of a transpositional deformity has been recognized and emphasized in the treatment of fractures about the ankle. In the upper tibial articulation no such stress has been laid upon the necessity of restoring its relation to the shaft of the tibia and cases have all too frequently been grouped as genu thus or that and submitted to routine supracondylar osteotomy, without an attempt being made to analyze the underlying mechanics. In malalignment of the lower tibial articulation the effort at restoration is directed to the site of deviation. In an identical condition at the upper tibial articulation, supracondylar osteotomy is often performed, though it must be perfectly clear that no amount of correction elsewhere than at the site of angulation can alter the intrinsic relationships of the shaft to the surfaces of the tibia. As a consequence the operative results in such cases, frequently inconsistent, have seldom been orthopedic in the literal sense of the word.

If non torsional deformities at the knee joint are considered, it will be seen that, mechanically, only three types are possible: those in which either the femur or the tibia alone is malaligned and those in which both bones contribute in varying degree to the appearance of the deformity. In the first where only the femur is angulated or curved supracondylar osteotomy at the site of the maximum deviation must obviously lead to a satisfactory result. In the second where the tibia is the site of angulation only tibial osteotomy can result in cure, while in the third osteotomy first of



Fig. 1. Note approximate parallelism of superior and inferior tibial articulations, both of which are approximately perpendicular to the longitudinal axis of the shaft.

one bone and then of the other is necessary before cure can be expected. The validity of these contentions will be readily recognized, if the principle of correction at the site of deformity be admitted.

Regardless of whether clinically the condition be a valgum, a varum, or a recurvatum, the site of deviation must first be determined before under taking any type of operative correction. This can be adequately done only by X-rays taken so that the whole tibia or the whole femur or where possible both be exposed upon a single plate. When such plates are compared with the normal (Fig. 1) it will be seen that in type 1 cases the tibial articulations are relatively parallel, while in types 2 and 3 they are convergent. In the varum cases because of the downward and inward inclination of superior tibial surface in relation to the longitudinal axis of the tibia, the articular planes converge medially. In the valgum cases, tibial surface tilts downward and outward and the articular planes converge laterally while in the recurvatum cases, the downward and forward angulation of this surface leads to convergence anteriorly. In all of these cases the abnormal angulation of the upper tibial surface in relation to the shaft is characteristic of the clinical picture and is the determining feature in the development of the deformity. It is in these types of cases that corrective juxta-articular partial tibial osteotomy in preference to compensatory supracondylar femoral osteotomy is to be used, as the following cases demonstrate.

GENU VARUM DUE TO DEPRESSED FRACTURE OF THE INTERNAL TIBIAL CONDYLE

CASE 1. R. S. female aged 23 years, gave a history of having injured her left leg when she jumped from a tree. Though not able perfectly to state what happened, the patient believes she suffered a fracture of the tibial condyle and of the fibula. This was apparently set and healed, but one year later because of the presence of a marked bowing, the bone was again fractured and reset. After the second operation the patient wore a lateral bar brace for over a year and has since then received no treatment. She was first seen in the early part of 1926, complaining of pain in the knee joint on walking, as well as dissatisfaction with the appearance of her bow leg.

There was no limitation of motion whatsoever in the knee joint. There was a moderate degree of bilateral bow leg, more marked on the left. The X-ray showed an old fracture in oblique the upper epiphysis of the medial condyle of the left tibia, with an old fracture of the upper end of the shaft of the fibula. There was marked depression of the inner half of the articular surface of the condyle (Fig. 2). On February 18, 1926, under general anesthesia and a tourniquet, a simple linear osteotomy was made about halfway through the upper portion of the left tibia and the medial condyle was levered upward. A longitudinal wedge shaped piece of bone was then removed from the shaft of the tibia and inserted into the gap formed by levering the medial condyle up and the shaft outward. The wound was closed in the usual manner and a plaster of-paris cast applied from the toes to the middle of the femur. Subsequent X-rays showed that the medial condyle had not been sufficiently elevated and the cast was consequently a rigid, so as to produce complete alignment of the femur and tibia. At the end of 6 weeks the cast was removed and physiotherapy begun. Since that time this patient has been repeatedly seen and has apparently been completely relieved both of her pains on walking and the psychogenic disturbances which she attributed to the deformity of the leg. Indeed, the leg operated upon is now straighter than her right leg, which apparently suffered no injury whatsoever (Fig. 3).

GENU VALGUM DUE TO PARTIAL SUBCHONDROSIS OF TIBIAL EPIPHYSIS

CASE 2. H. K. male aged 9½ years, was seen in the Out Patient Department in the middle of 1927 with a history of his leg being run over by a truck. Because of the compound fracture and the extent and severity of soft tissue injury immediate amputation was advised at one of the city hospitals to which the child, as taken. The parents objected to this procedure and subsequently the patient was removed to another hospital, where after several months of care, the wounds finally healed. When seen at our hospital the knee was in severe valgus, with abnormal mobility in all directions. It was felt that conservative treatment was best indicated and a brace was consequently ordered and the patient observed for several months. On May 5, 1928, the boy was again admitted to the hospital. Osteotomy of both tibia and fibula was performed for the correction of a knock knee deformity. The deformity was apparently corrected and the patient was discharged on June 15, 1928. However it appears that several months later the correction did not appear to be satisfactory since the patient was again admitted on December 18, 1928 for the performance of a supracondylar osteotomy of the femur. On January 3, 1929, he was discharged. On June 3, 1929, the patient was submitted to a tenotomy of the Achilles tendon to correct a pes equinus.



Fig 2A.



Fig 2B



Fig 3A



Fig 3B

Fig 2 Photograph showing bowing of the left leg, with röntgenogram showing depression of the inner half of the tibial condyle downward and inward tilting of the suprapatellar fat pad.

On March 23, 1931, he was again admitted to the hospital, walking with a marked limp to the left, the left limb being lower than the right. There was still abnormal mobility of the knee joint in all directions, with ten degrees of internal rotation of the foot. The measurements were: left ankle, 27 3/4 inches; right ankle, 29 inches; left tibia, 21 inches; right, 23 1/2 inches; left fibula, 21 3/4 inches; right, 23 1/2 inches. The angle of greatest extension at the knee was 170 degrees, the angle of greatest flexion 85 degrees. There was a severe genu valgum, with external bowing of the femur. The foot presented a moderate varus of the heel, with adduction of the forefoot. There was a definite scoliosis to the left. The X ray film showed a lateral bowing of the femur at the site of the previous osteotomy and marked retardation of growth in the external half of the upper tibial epiphysis. The lateral condyle was definitely irregular and depressed below the level of the head of the fibula (Fig 4).

It was felt that the only satisfactory procedure in this case would involve the raising of the articular surface of the lateral condyle to its normal position above the head of the fibula. Consequently on March 26, 1931, a longitudinal incision was made over the superior tibiofibular articulation and the lateral condyle of the tibia was exposed. With a broad osteotome, the lateral half of the tibia was cut through and the external tibial condyle definitely levered upward so that it came to lie above the upper edge of the fibula. A longitudinal wedge from the shaft of the bone was thereupon removed and placed in the osteotomy wound. In an attempt to supply a force which might tend to push the lateral condyle upward as growth of the internal portion of the epiphyseal line took place, the head of the fibula was split longitudinally and bifurcated so that the medial portion came to lie against the inferior surface of the lateral condyle. The wound was thereupon closed in the usual manner and a plaster-of-paris cast applied from the toes to the mid thigh. Subsequent X ray pictures showed that not quite complete correction had been obtained and it was then realized that the cause

Fig 3 Tibial articulation in relation to the shaft of the femur. The same patient, showing result following operation.

for the failure was to be sought in our neglect in releasing the long fibular collateral ligament which bound the head of the fibula to the condyle of the femur and so prevented correction.

In July 1933, after preliminary isolation of the peroneal nerve, the operation described was again performed with this modification: the long external fibular collateral ligament was first detached from its insertion into the head of the fibula and reinserted into the outer surface of the tibial condyle, to maintain the stability of the knee joint. Osteotomy of the external tibial condyle now permitted slight overcorrection of the plane of the articular surface in relation to the shaft of the tibia, with elevation of the condyle in relation to the head of the fibula. In August, after fairly firm union of the tibial osteotomy had taken place, a Grattan osteoclasis of the femur for the correction of the femoral bowing was undertaken. Patient discharged in October, walking with leg corrected for first time (Fig 5).

It will be noted that marked improvement in the spinal curvature has already taken place. The compensatory varus of the foot is still present, but it is hoped that weight bearing within a relatively normal line of force will result in a gradual correction without the remodelling operation upon the foot, which will otherwise be necessary. Because of the fact that the inner half of the tibial epiphysis still retains the power of growth which has been lost in the outer half, this patient may again develop a valgum deformity. In that event re-operation will probably again be indicated.

GENU VARUM PROBABLY DUE TO A RACHITIS

CASE 3. G. P. male, aged 13 1/2 years, was admitted to the hospital with a complaint of bow legs. The mother stated that the child had been a full term, normally delivered



Fig 4A



Fig 4B



Fig 5A



Fig 5B

Fig 4. Note downward tilting of the pelvis to the left, with scabiosa to the same side outward bowing of the left femur abduction of the left leg with genu valgum at the knee, marked scarring of the left leg, varus and equinus of the left foot. X-ray film shows a downward and outward

tilting of the superior tibial articulation, with relative elevation of the head of the fibula above its normal level.

Fig 5. After operation and removal of cast. Note improvement in curvature of back, alignment of lower extremities and tendency toward correction of foot deformity.

baby who at the termination of nursing had been fed on a formula fortified by the addition of cod liver oil and orange juice. The baby had developed normally and had begun to walk at the age of 6 months. At the age of 1 year the child had measles and chicken-pox.

On admission the child was apparently normal, but for the legs, which showed a typical O shaped bowing. This appeared to be partly due to a deformity in the lower end of the femur but more to an angulation just below the inner condyle of the tibia. At this point there was a definite depression, which is easily seen, both on the photograph and on the X-ray (Fig 6). It will be noted that in addition to a slight curvature of the femur above the joint line, there is marked downward and inward inclination of the superior tibial surface in relation to the shaft of the tibia, so that the upper and lower articular planes tend to converge on the medial side of the leg.

On August 31, 1933, the child was operated upon under general anesthesia. A simple linear osteotomy of the inner half of each tibial condyle was made and the shaft of the tibia levered outward until the head of the tibia was approximately perpendicular to the longitudinal axis of the bone. A small graft of bone was then removed from the lower portion of the shaft and inserted into the wedge, which had been opened. Plaster-of-paris bandages were then applied in the usual manner. Apart from a slight alignment by wedging of the cast, the convalescence was uneventful. When seen in October, the child was clinically well. The depression on the side of the leg had disappeared. The X-ray showed that the tibial surfaces were relatively normally aligned to each other and to the shaft of the tibia. There was still slight bowing of femur not of sufficient degree to warrant operation at the present time (Fig 7).

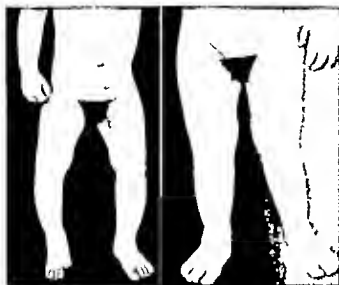
GENU RECURVATUM PROBABLY DUE TO IMPACTED FRACTURE

CASE 4. A O male, aged 15 years, was seen in the Out-Patient Department in February, 1933, with a complaint of gradually progressing "back-knee," which had

been noted by the mother. The boy originally came under observation in April of 1929. At this time he presented the picture of a typical Froehlich's syndrome. In addition, he was suffering from an epiphyseolysis of the right hip, for which he received treatment by means of a plaster-of-paris spica and subsequently by means of a walking hip brace, which was worn for a period of 3½ years. When the brace was removed, the lump and the limitation of abduction and internal and external rotation at the hip which had previously been noted, had completely disappeared. For about 6 months the child was apparently entirely well, when the mother noted a progressive back- and sagging of the knee. There was no history of trauma, and apart from the deformity no symptoms, either of pain or disability.

On admission to the hospital, the child was noted to have the characteristic obesity, pubic hair line, etc. of the "fat boy." The right hip was normal in all ranges of motion. The right knee showed a marked prominence of the patella and the femoral condyles. There was a definite recurvatum and a corresponding increase in the range of extension at the knee to 135 degrees. The X-ray showed a marked forward and downward tilting of the superior articular surface of the tibia. Below the epiphyseal line between it and the apophysis of the tibial tubercle, there appeared to be a definite infraction of the cancellous tissue of the tibia. Instead of a prominence, there was a definite depression at the site of the tibial tubercle (Fig 8). Whether this represented an impacted fracture at this site or an endocrine disturbance of apophyseal growth, similar to that of the femoral capital epiphysis, cannot be stated, and for the purpose of this communication, is immaterial. It may however be noted in passing that in August following his discharge from the hospital, the patient stumbled and suffered a barely discernible fissure fracture of the internal malleolus of the same leg.

Whatever the underlying etiology it was recognized that the basic indication was for restoration of the normal relationship between the plane of the articular surface and the longitudinal axis of the shaft of this tibia. Ideally, the osteotomy should have been performed at the area of de-



Before. After

Fig. 6. Typical O shaped genu varum. Note marked medial convergence of tibial articulations. Left, before; right, after correction.

pression below the tibial epiphysis, but, because of the attachment of the patellar tendon, this would have been impossible without preliminary transplantation of the insertion of the tendon. This, naturally, was not considered, and in March, 1933, a simple oblique osteotomy of the tibia was performed through an external incision after careful isolation of the peroneal nerve. The plane of the incision extended from below the tibial tubercle, backward and upward into both condyles.

With the patellar ligament acting as an internal fixation for the upper fragment, the lower portion of the shaft of the tibia was easily levered away from the osteotomized fragment, until fluoroscopic examination established the correction of the inclination of the articular surface. The wedge thus opened was maintained by the insertion of a small bone graft and the leg was enclosed in plaster-of-paris, with the knee in flexion. When the X ray demonstrated bony union, the cast was removed and exercises were instituted for the restoration of power in the muscles of the leg. By July the boy was discharged with normal function and with no evidence of any residual recurvatum (Fig. 9).

The 4 cases, here reported were chosen as typical examples indicating the treatment of angular deformities about the knee joint. Whatever its significance may be as to prognosis, the underlying etiology of the condition plays no part in determining the operative indication. This is clearly a restoration to the normal by correction of the deformity. The decision as to the best site for operation can be arrived at only by careful study of the X ray of the whole leg. The crux of the problem is the relationship of the tibial articular surfaces to each other and to the shaft. Provided the articular planes are normally parallel, supracondylar osteotomy is indicated, but when this is not the case, operation elsewhere than at the site of deformity is doomed at the outset to



Before. After

Fig. 7. Same patient as in Figure 6. Note that after correction the tibial articulations were parallel with an S shaped curve in the shaft of the tibia.

mediocre result or still worse to failure. When the underlying causes may be overcome, as in rachitis or when they have ceased to act, as in the fracture cases, a single correction of the resultant mechanical defect may lead to permanent cure. But if, as in the case of partial synchondrosis in a still growing child, the cause cannot be eradicated until growth has ceased, the prospect of reoperation at properly timed intervals must be entertained. However this prospect is not as gloomy as it would at first sight appear since it permits of repeated realignment of the bones and the re-establishment of a relatively normal line of force with avoidance of abnormal stresses and consequent compensatory changes in all parts of the column of force.

The procedure is simple and apparently rational. The osteotomy is best performed at or above the level of the head of the fibula, so that the relation of the shaft to the head of the tibia can be altered without the necessity of fracturing the fibula. In growing children the line of osteotomy should, of course, be below the epiphyseal line so as to avoid injury to that structure. In older individuals the line of incision may be nearer the joint surface, but always below the line of attachment of the capsule or the large extrinsic ligaments, which act as the stabilizing forces upon the short, condylar fragment at the time of the maneuver of levering the shaft into proper alignment.

Preferably the inner side of the tibia is chosen as the site of osteotomy to prevent injury to the peroneal nerve. In cases of varus, a simple, partial osteotomy, with the opening of a wedge



Fig. 8

Fig. 8 Right back knee. Note downward and forward inclination of tibial articulation.



Fig. 9

Fig. 9 Same patient after operation. Note the superior tibial articulation now bears normal relation to the shaft of the bone and that an attempt has been made at restoration of the normal prominence of the tibial tubercle.

suces. In cases of valgus, the removal of a wedge of bone, with internal angulation of the lower fragment, is all that is necessary provided the head of the fibula is in normal relationship to the outer and under surface of the external tibial condyle. Where this is not true as in Case 2 reported the operation must be performed upon the outer condyle after preliminary release of the external fibular ligament which otherwise maintains the relation of the head of the fibula to the external femoral condyle, and so prevents correction. Ordinarily the osteotomy need not be completely across the bone. Except in the most severe angulation cutting of half or at most two-thirds of the bone readily permits of green-stick fracture of the other portion and correction of the deformity.

Apart from the fact that it is designed to meet a mechanical problem at what is mechanically the optimum site, the procedure seems to have several other desiderata and at least one serious drawback. Because the tibia is not completely osteotomized, the likelihood of non-union or of undesired displacements, due to muscle pull, is obviated. Because of the possibility of accurately choosing the site of osteotomy the danger of injury to the epiphysis or to the ligamentous structures about the joint is avoided. On the other hand by the very nature of the operation, the elimination of torsional deformities is precluded. For such cases, where marked torsion of the leg is associated with convergence of the tibial surfaces, complete section of the bone is necessary before correction can be obtained.

PRE OPERATIVE PREPARATION OF THE DILATED STOMACH

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IN many cases of pyloric obstruction due to ulcer or malignancy the stomach may show a marked degree of dilatation. The muscle tone of such stomachs is much reduced and they hang in the abdomen like a bag filled with stagnant liquid food particles, and tenacious mucus.

As a general surgical principle it is unwise to do extensive operations upon any acutely distended portion of the gastro-intestinal tract. When the

stomach or bowel wall is overstretched by distention the tone is not only lost but the blood supply is disturbed. Such a viscus may not heal normally and restoration of function is likely to be delayed. To restore the tone and blood supply is, therefore much to be desired before operation.

A markedly dilated stomach may be restored to normal size in an average of 4 to 6 days by using the continuous gastric lavage with suction



Fig. 1. A Dilated stomach due to pyloric obstruction. B Stomach reduced to normal size after lavage. Barium

has passed through pylorus. C. Stomach after gastro-enterostomy.

An in-dwelling Levine tube passed through the nose is suitable for this purpose. At the beginning of such treatment, it may be necessary to lavage the stomach through a large tube to remove particles of food and mucus too large to pass through a Levine tube. With the nasal tube in place the patient is urged to drink as much water as possible. All water secretions, and gas are promptly removed from the stomach by continuous suction. After a few hours lavage liquid will frequently begin to pass through a previously completely obstructed pylorus. This may be demonstrated by the administration of a small quantity of barium solution.

During continuous lavage careful attention must be given to maintenance of chemical water and metabolic balance. Before the treatment is started a study of the blood chemistry may indicate the need of sodium chloride. Water salt and glucose should be given by vein or hypodermoclysis. Since a loss of the gastric juice reduces the body chlorides a daily check of the blood chloride content is advisable.

Figure 1 illustrates a widely dilated stomach which was reduced to normal dimensions after 10 days treatment. This patient developed complete pyloric obstruction due to a carcinoma. During the continuous lavage suction treatment several transfusions were given in addition to the daily administration of glucose sodium chloride solution by vein and physiological salt solution by hypodermoclysis. After the tone of the stomach was reduced to normal a gastro-enterostomy was done and recovery was not accompanied by any complications.

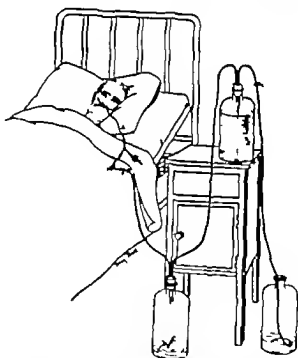


Fig. 2. Suction apparatus used for continuous gastric lavage. This is a modification of methods recommended by Ward and later by Wangensteen. Bottles 2 and 3 are interchangeable. When the high bottle 2 is empty and the low bottle 3 is full, the two are reversed by transferring the rubber cork. Tube D is kept full of water with its lower end immersed in water at the bottom of bottle 3.

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SPINAL ANÆSTHESIA IN FACT AND FANCY

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A SIMPLE surgical procedure attracts attention when conducted with an imposing ritual. A dangerous method is accepted with confidence when given a talisman to imply safety. Pin the medal of St. Francis to a questionable technique and its dangers are ignored until brought home by better experience. Thus it has been with spinal anesthesia.

By various innovations, spinal anesthesia has repeatedly been revived from dark days when it was distrusted and feared into the light of wide acceptance and laudation. A new drug, the dehydration or other modification of an old drug, a dash of strychnine, caffeine, or epinephrine in the ampule as a stimulant or a fraction of sugar gelatin, serum, starch, alcohol to imply controllability have been amulets that repeatedly have restored confidence to a more or less discredited procedure. Again, a position of the patient or the tilt of the operating table, a new name for an old drug, a modification of the needle or method of injection, or the coincident use of special stimulant has been a symbol of safety.

But by none of these measures has spinal anesthesia been made fool-proof, controllable, or even safe, when used carelessly and indiscriminately. No solution or technical innovation has displaced the necessity for an accurate technique and rigid supervision. The dangers of spinal anesthesia remain largely with the user rather than the drug or technique employed. Spinal anesthesia is a most valuable method and its ill effects represent blunders from its improper use. Many conflicting opinions on the subject are spread through the literature to the confusion of the student, and not a few are due to misleading laboratory observations. In the experimental laboratory, working with lower animals, it is difficult for the highly trained comparative physiologist to avoid error. Hundreds of dogs have been sacrificed to disprove what may easily be demonstrated by careful observations made upon the patient under spinal anesthesia. We read that the puncture of the spinal cord by the needle is fatal, that intradural valves are present that increase the intraspinal pressure in some mysterious way toward the head that death from spinal anesthesia never occurs from asphyxia, that the depression of spinal anesthesia is a condition of shock, that a primary depression and dilation of the heart causes the

fall in blood pressure that the toxic effects are due predominantly not to a direct effect on the cord or spinal roots but to the absorption of the drug by the blood vessels by which only it is carried to and depresses the centers of circulation. Take, for example, the widely quoted experiments of Spielmeier of 25 years ago indicating that the injection of stovaine into the dura produces a very serious degeneration of the dog's spinal cord. At the time we had these experiments repeated and learned that in dogs such injections were followed by a permanent paraplegia. But no paraplegia followed 15,000 injections of stovaine in man. The reason is a technical and an anatomical one. The spinal cord in the dog so largely fills the dural space and the spinous processes so overlap that it is difficult to enter the cavity of the arachnoid or to withdraw more than a few drops of spinal fluid without puncturing the cord, whereas in man there is a large spinal cavity easily entered, from which 30 to 45 cubic centimeters of spinal fluid may readily be withdrawn. Even with the dura exposed by a laminectomy the experimenter will often inadvertently inject or damage the dog's cord with his needle. Besides this, the diffusion and diffusion of the drug, which plays such an important part in the clinical application of spinal anesthesia, cannot adequately be reproduced in the lower animal. In Spielmeier's experiments the undiluted stovaine solution, a protoplasmic poison accidentally entered the cord. In contrast, secondary symptoms from degeneration of the cord apparently never occur when the injection is properly given in man even though the injections are made above the level of the cauda equina. As many as twelve injections of stovaine, given to one patient for repeated operations, were followed by no evidence of spinal injury. It is to be hoped that future writers on the subject will not continue to repeat the errors of Spielmeier which apply even less to the mildly toxic procaine now in general use. Quite different is the selective degenerative action on the cord from the injection of a drug like methyl alcohol. We have seen two patients who had permanent localized spinal palsies from the injection of a spinal anesthetic solution contaminated by a small quantity of wood alcohol.

Procaine hydrochloride U.S.P. (Pain anæsthetic—diethylaminoethyl hydrochloride) also sold under various trade names as Novocaine, Neocaine, etc.

To prove the safety of high spinal anæsthesia, experiments have been described indicating that procaine, injected within the arachnoid, does not produce respiratory or other type of motor paralysis. Some of the earliest experiments with spinal anæsthetic solutions showed that when these were dropped upon the exposed upper cord or medulla the respirations of the animal promptly ceased but if artificial respiration was used until the effect of the drug had passed off the respiratory function would return—otherwise the animal would die of asphyxia. Such experiments showing motor paralysis have been repeated many times and are confirmed by thousands of clinical observations. We have seen in the clinic, several instances of primary respiratory failure from the high effect of the spinal anæsthetic the voice fading to a whisper and disappearing as the air currents ceased, although the heart continued to beat. At least 3 such patients were saved by timely artificial respiration. Other experiments are advanced to prove that the motor paralysis is not due to a block of the posterior nerve roots, which are considered to be immune to the spinal anæsthetic, but to a break in the reflex arc from the anesthetized posterior nerve roots. The explanation of these conflicting observations lies in the fact that the posterior nerve roots are more susceptible to procaine than the anterior or motor roots. From dilute or weak solutions of procaine we have repeatedly seen a perfect analgesia with retained motor power indicating that the block of the posterior roots does not reflexly cause muscular relaxation. From more concentrated solutions of procaine a block of the anterior nerve roots with temporary muscular relaxation and paralysis is observed. The experiments of Johnson and Henderson indicate that in the dog concentrations of $\frac{1}{4}$ to 1 per cent of procaine are sufficient to block the posterior roots and thus interrupt pain producing impulses while $2\frac{1}{2}$ per cent is required to block the posterior roots and suppress motor impulses.¹ If these percentages are applicable in the clinic, which to some degree seems probable, 120 milligrams of procaine dissolved in but 6 cubic centimeters of cerebrospinal fluid would have a concentration too weak to cause motor palsy. Because motor including respiratory, paralysis does not follow the application of dilute solutions there is no reason to assume that motor paralysis never occurs or that when present it is merely a reflex effect.

The cause of the usual circulatory hypotension has been repeatedly sought. Certain experimenters following an old and discarded theory of

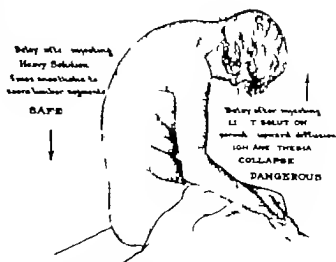


Fig. 1. Illustrating the effect of delay in placing the patient from a sitting to a recumbent position after the injection of spinal anæsthetic solutions lighter than or heavier than, the cerebrospinal fluid.

traumatic shock, have looked for segregation of blood in the splanchnic veins. Not finding this, the presence of a primary peripheral vasoparesis has been denied. The clear evidence that the peripheral circulation of blood is increased, easily shown by the remarkable rise in the temperature of the extremities under spinal anæsthesia is overlooked and experiments on dogs paraded to support opinions to the contrary.

Out of much conflicting experimental evidence, an observation of Gray and Parson and supported by experiments of Severs and Waters (loc cit.) is impressive. This is the immediate disappearance of much of the circulatory hypertension when an adequate to and fro type of artificial respiration is established. In other words circulatory depression is largely the result of paralysis of the muscles of the thoracic cage. The defective inspiratory movements of the chest are attended by a loss of the aspirating effect upon the blood stream. The right heart receives less blood from the venæ cavae and beats slower and propels less blood. But, you contend experiments show that the exposed heart of the dog under spinal anæsthesia is primarily dilated and depressed. True, but the experiment was faulty. We know that if the experimenters had not destroyed the respiratory circulatory equilibrium by opening the chest but had merely studied the dog's heart under the fluoroscope they would have found the heart contracted rather than dilated under the anæsthetic. Isenberger and Lundy gave a dog 2500 milligrams of procaine (50 per cent solution) by lumbar injection with resultant complete paralysis, yet from adequate inflation and defla-

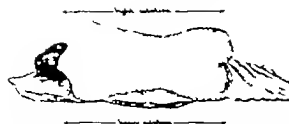


Fig. 2 With the patient remaining upon the side during and after the injection and the spine horizontal, the diffusion of both light and heavy anesthetic solutions is both cephalad and caudad.

tion of the chest alone the animal was kept alive for 10 hours without change in blood pressure or pulse rate. Unfortunately we as yet know of no method of maintaining adequate negative pressure in the patient's chest during inspiration while the chest wall is paralyzed by the spinal anesthetic. As a result the heart starved of blood beats slower propels less blood and the pulse becomes slow and weak. The peripheral vasoparesis is evidently a minor cause of the hypotension.

Demonstrations have been made to show that in the dog harmful peristaltic contractions may occur so violent as even to tear peritoneal adhesions. Writers have also repeatedly warned against the use of spinal anesthesia if there is a perforation or rupture of the stomach or intestine. The warning is based on theory not practice. For over 25 years we have operated in nearly every case of a perforated intestinal viscus with spinal anesthesia and have never observed leakage that coincided with the peristaltic contractions, nor have we seen the contractions tear



Fig. 4 If the injection is made with the patient upon the side and the spine curved over a pillow heavy solutions will tend to gravitate toward the head and sacrum. Light solutions remain in the lumbar region with resultant imperfect anesthesia of the abdomen.



Fig. 3 If the spine is curved toward the operating table light solution injected in the lumbar region will by gravity diffuse toward the head and sacrum while other things being equal, a heavy solution will remain in the lumbar curve.

or strain organized adhesions. Indeed, the peristaltic waves under average doses of procaine are mild and often inconspicuous, and we consider the excitement stage of ether as much more potent in causing intraperitoneal leakage or other damage.

But clinical observations and opinion may also be misleading. Modern Galens and Aristotles continue to spin the cobwebs of a fanciful philosophy with spinal anesthesia as with other debated subjects. Arnaud and Cremieux attribute complications to a meningeal reaction. Leriche to hypotension from leakage of cerebrospinal fluid. Daniel and Valerio to a general sympathetic disequilibrium followed by a colloidoclastic shock. To prevent the supposed humoral crisis Daniel first prepares the patient by an intravenous injection of cerebrospinal fluid. This injection is supposed to desensitize the organism and thus prevent the anaphylactic shock. Measures to render spinal anesthesia safe have often been based on theory. Jonnesco, in 1908, claimed that strychnine was a perfect antidote for the depression from stovaine. This was not confirmed and 14



Fig. 5 By turning the patient on the face after the injection of light solution, a better anesthesia of the abdomen is thus obtained for the reason that by gravity the solution ascends into the more elevated thoracic curve.

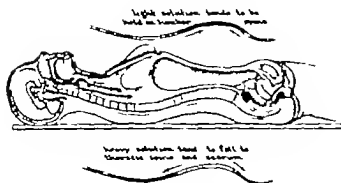


Fig 6 If, after making the injection with the patient upon the side, the patient is immediately turned upon the back, a light solution by gravity tends to be held in the lumbar spine with lack of anesthesia in the abdomen. On the contrary a heavy solution tends to gravitate both into the lower thoracic spine and sacrum and a higher and more complete anesthesia of the abdomen results

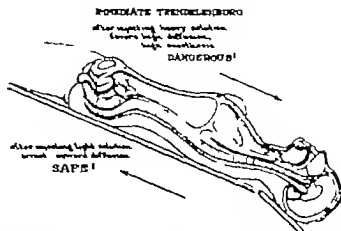


Fig 7 If after injecting a heavy solution such as novocain dissolved in cerebrospinal fluid the patient is immediately placed in the Trendelenburg position gravitation toward the medulla may produce high and untoward effects. By waiting 10 minutes for the fixation of the anesthetic to the spinal roots before lowering the upper part of the body this danger is largely averted. The Trendelenburg position is safe and desirable after the injection of light (alcoholized) anesthetic solutions

years later he extolled caffeine which others had previously used and discarded. Gravity control by the use of heavy solutions advocated by Barker and others has been tried only to be largely abandoned. It has been asserted that the addition of a starch preparation to the solution will prevent diffusion and limit the toxic absorption of novocain the anesthetic remaining as a non diffusible or controllable liquid globule in the dura with resulting efficiency and from lack of toxic absorption, of great safety. For this fanciful assertion we can find little basis in fact. If you will color with a trace of methylene blue both the spinocaine solution and also a similar solution made without the starch and float the two solutions in tubes containing cerebrospinal fluid it will be observed that the spinocaine really is the more diffusible. This is probably due to the hygroscopic quality of the starch. In practice a simpler and relatively inexpensive water alcohol and novocain mixture shows no loss of efficiency from the lack of gliadin while the mortality which has attended the use of spinocaine controverts the asserted lack of toxicity. The suggestion that for safety the novice in spinal anesthesia should spend from 20 to 40 minutes in first dissolving the anesthetic in blood serum or that the action should be localized by graded intermittent injections of air and the anesthetic as advocated by Kirschner, will hardly meet with wide acceptance. A heavy concentrated colloid solution injected without diffusion is much more dangerous from its more intense action on motor roots than a diffused dilute solution which only rarely will produce dangerous motor paralysis.

Most observers also overlook the agitating and diffusing action of the sinuses and veins in the human dura which distend and collapse with each

respiratory cycle and of the arterial loops within the arachnoid which oscillate with each heart beat and serve to mix the anesthetic with the spinal fluid.

In recent years and despite very poor statistical evidence ephedrine has been the talisman of safety for spinal anesthesia, yet many more deaths have been reported under spinal anesthesia when ephedrine was given than when it was not given. It is admitted that in part this may be due to the predominant use of the drug. Yet, if there is inadequate oxygenation of the tissues a condition that so frequently occurs from the circulatory hypotension of spinal anesthesia, ephedrine not only fails to stimulate, but according to the experiments of Severs and Waters¹ and others, it actually depresses the heart. Indeed the stimulation produced by ephedrine is lost even when a relatively slight anoxemia develops. In other words when most needed this drug not only fails to stimulate but causes circulatory collapse. The electrocardiographic studies of Chen and Meek² show the toxic qualities of ephedrine in sufficient dosage as indicated by progressive paralysis of the conduction bundles and finally, the hopeless condition of ventricular fibrillation. In general practice collapse has been reported in cardiopaths and asthmatics from an idiosyncrasy to ephedrine. With spinal anesthesia deaths have occurred after the smaller doses of ephedrine as used by Pitkin and the larger doses advocated

¹ Researches in Anesthesia & Analgesia, March-April, 1911
² J. Pharmacol. & Exper. Therapy 1926 xxvii, 3



Fig. 8. By diffusion and dilution the efficiency of a spinal anesthetic is reduced as it travels from the point of injection. Thus, 50 centigrams of procaine injected through the twelfth thoracic interspace gives an upper abdominal anesthesia equal to 30 centigrams injected through the fourth lumbar interspace, while only 5 centigrams injected through the seventh cervical interspace gives an upper thoracic anesthesia equivalent to 30 centigrams injected through the fourth lumbar interspace.

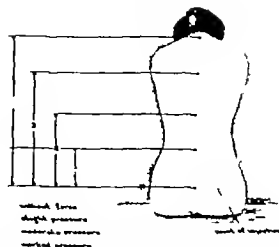


Fig. 9. Illustrating the influence of forcible injection upon the diffusion of spinal anesthetic. If the injection is introduced without force through the second lumbar interspace a heavy solution falls to the sacrum. By slight pressure, despite a sitting position, the anesthetic is driven to the lower thoracic space, while more forcible injections may produce effects upon the thoracic and even cervical nerve roots.

by Stout. After hearing the startling report by Sizé of 12 deaths in about 200 injections of spino-caine given in or near Boston, one wonders how the mortality could have been higher had the ephedrine been omitted. No one as far as I know has reported as low a mortality from intradural anesthesia with ephedrine as that we have observed without ephedrine (10,000 injections between deaths). Ephedrine greatly increases the pulse rate and the work of the heart. Because it usually raises the blood pressure and makes the heart beat faster is no proof that it renders the anesthetic safer. All admit that it is unreliable in the grave emergency. No one contends that it approaches epinephrine as a cardiac stimulant. It is my opinion that such a tricky and potentially dangerous drug should no longer be used routinely. It has been asserted that the action of epinephrine is too transient to be of value in spinal anesthesia. This, of course, is not true. The period of circulatory stimulation from epinephrine of 15 to 30 minutes is usually longer than the period of intense depression from spinal anesthesia. By carefully graduated, intermittent, or continuous administration of epinephrine the stimulating effect may be prolonged for hours.

The anesthetic drug selected has frequently been blamed for the untoward effects of spinal anesthesia. Cocaine, stovaine, alypin, tropocaine, apothesine and tutocain have been praised and condemned. Yet cocaine, oldest and most

discredited of the intradural anesthetics continues to be used with much success in the General Hospital of Mexico City. It is also true that the toxic stovaine may be used with a very low mortality. And when all has been said it is evident that the danger lies more with the user than in the drug for any of these agents used with skill will give efficient and relatively safe anesthesia, while the weakest may cause a fatality when used without care. The selection of the patient is especially important. While we admit that procaine from its low general and local protoplasmic toxicity has manifest advantages, we must confess that even cocaine skillfully used may be safer than procaine used carelessly. After a death from spinal anesthesia the anesthetist may often properly write his own name in the space on the certificate reserved for "cause of death."

Postanesthetic headaches have repeatedly been ascribed to the size or shape of the spinal needle used. Large needles and those with acute sharp points are asserted to be responsible for the extradural leakage of cerebrospinal fluid and post-anesthetic headaches. It is claimed that only a very obtuse pointed needle without sharp edges cuts a trap door in the dura which limits leakage and prevents headaches. If one will experiment with a section of dura or similar membrane he will find that the sharp edged, acute point, cuts a better trap door than the relatively dull, obtuse

pointed needle. But while we do not favor a large needle or one with a long point a well sharpened needle enters the tissue with the least pressure or pain and best conveys to the hand the relative densities of the various tissues traversed. Such a delicate, well sharpened needle inflicts no more pain than the needle so often and so unnecessarily used to anesthetize the relatively insensitive tissues of the back before the spinal needle is introduced and is less subject to deviation or harmful or plunging effect on reaching the dura. The needle should be of 20 or 21 B & S gauge. A needle of 22 gauge or finer has too small a lumen and is too flexible to be properly guided. A needle with an accurately ground slip joint is preferable to a lock joint which requires manipulation that may lead to displacement as the syringe is adjusted.

As for headaches, we have long observed that it is the solution used and not the sharpness or size of the needle that is chiefly responsible. We have largely eliminated postanesthetic headaches not by changing the needle but by changing the solvent. In the early days tap water and old distilled water evidently produced meningeal irritation for when without changing the needle fresh triply distilled water was substituted the heavy incidence of postanesthetic headaches disappeared. It is quite evident that the needle and syringe may not be blameless when poorly cleansed, or boiled in tap water or with other instruments, or in pans with a soluble coating. The intradural reactions resemble in a measure those from the intravenous injection of old distilled water or water contaminated by passing through rubber tubing. Unquestionably there is more hysteria than truth in the prevalent notion that leakage is the major cause of headache following intradural anesthesia.

An old error was the assertion that the spinal anesthesia, *per se*, causes abducens palsy with its associated meningism and 6 or 7 day period of incubation. Six of my patients had this startling but fortunately usually temporary affliction after spinal anesthesia. It is a bacterial effect and in our experience was due to imperfectly sterilized imported solutions. For 20 years, or since we have used aseptic anesthetic preparations, we have not seen a case.

It has been observed that the zone of anesthesia is higher and more complete after injecting spinocaine if the patient is turned upon his face for a few moments immediately after the injection. It has been assumed that such a maneuver causes the gravitation of the lighter anesthetic mixture to the posterior nerve roots. But there

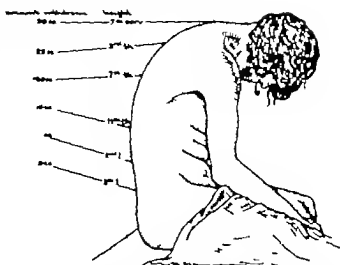


Fig. 10 Even with the patient in a sitting position the upward diffusion and activity of a local anesthetic injected through a lower lumbar interspace is greatly increased by the previous withdrawal of cerebrospinal fluid. By the withdrawal of 30 cubic centimeters of cerebrospinal fluid anesthesia to the neck may be produced.

is really but little anatomical separation of the anterior and posterior roots. The peculiar results obtained are clearly explained by gravity in relation to the spinal curves (Fig. 5). Gravity, volume and diffusion are three great factors in spinal anesthesia to be always considered. They cannot be reproduced in the limited intradural space of the dog. But one observer protests that he uses a heavy solution and observes no effect from gravity while another says his technique is the same yet from gravity he has obtained alarming symptoms. Both dissolve novocain in cerebrospinal fluid and reinject it through the same lumbar interspace but the first man finds he can at once place the patient in the Trendelenburg position while the second has had high and untoward effects from such lowering of the head. Apparently the techniques are the same but closer study shows important differences. The first dilutes and thoroughly mixes the novocain so that the specific gravity of the injected solution is lowered and the effect on the motor nerves minimal. The second with the same dose of novocain uses less dilution so that he really employs a heavier solution that gravitates with greater speed—or it may be that he injects more forcibly and without barbotage and thus aids the movement toward the patient's head of a more concentrated and therefore a more paralyzant solution.

I shall not attempt to tell of a better technique for spinal anesthesia than the one you are using. Most operators are individualists and resent dislodgement from the pet methods that they have

found suited to their personal idiosyncrasies. Nor shall I attempt to impart to you the magical gesture or hocus pocus of safety and efficiency but if I have impressed you with the thought that fanciful theories may have the support of

laboratory and philosophical consideration that undue credulity does not advance the cause of spinal anesthesia, and that after all it is wise for each operator to think for himself the object of this paper will have been accomplished.

A SIMPLE METHOD OF PERFORMING EXTERNAL PERINEAL URETHROTOMY

A REPORT OF ITS VALUE AFTER FIFTEEN YEARS

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IN the February, 1918, number of *SURGERY, GYNECOLOGY AND OBSTETRICS* I described a method of performing external perineal urethrotomy which so far as I know was original. The operation had at that time been successfully employed by me and by some of my associates in a considerable number of cases, and I felt then that it had stood the test of actual trial. An additional 15 years of experience with it has convinced me that, under appropriate circumstances, it is by far the easiest and most efficient way of establishing perineal drainage.

My original description of the operation may well be repeated for the benefit of those who are unfamiliar with it.

A soft rubber catheter well lubricated and of suitable size (16 to 18 French scale) is passed through the urethra into the bladder in the usual manner but it must be inserted until its distal or outer end is almost level, according to circumstances, with the external meatus or with the orifice of the urethra. This end of the catheter is then grasped with a small clamp preferably with a half-curved shank. The catheter and clamp are then pushed on into the urethra until the point of the clamp can be felt pressing against the floor of the bulb. The free portion of the catheter meantime has passed on into the bladder. The point of the clamp is now made to impinge against the perineum bulging it sharply outward in the median line. An incision from 1 to 2 cubic centimeters in length is now made through the median raphe, the tissues being divided until the point of the clamp, the catheter still in its grasp is exposed and worked through the incision. The end of the catheter is then firmly held with the fingers or by another clamp the first clamp being then opened and withdrawn backward from the urethra, thus leaving the catheter emerging from the

perineal incision. The catheter is then drawn out until its eye occupies a suitable position within the bladder for uninterrupted drainage. Two transverse sutures are now taken, one above, the other below the catheter, each being tied around it. These sutures should be passed quite deeply so as to include the corpus spongiosum, thus not only controlling whatever bleeding there may be, but also anchoring the catheter firmly in place. Silk sutures are quite satisfactory, those of silk worm gut are better in that if the catheter is not adjusted quite accurately they can be readily untied and the catheter moved in or out. The urinary stream is now completely and comfortably diverted for as long a time as is necessary.

It was stated in my original communication that this method of perineal urethral drainage was applicable in any operation where diversion of the urinary stream was indicated. These operations include amputation of the penis and plastics for hypospadias and epispadias. In all these operations, the patient is ordinarily placed in the dorsal position. The parts are prepared in the usual manner, this preparation including the skin of the scrotum, the inner aspect of the thighs, and the perineum. The performance of external urethrotomy requires only that the thighs be separated sufficiently to enable the surgeon to expose and incise the midline of the perineum as far posteriorly as possible, but not so far back as to injure the external urethral sphincter or that of the rectum. To do an external urethrotomy by the usual method would involve putting the patient in the lithotomy position, a procedure involving time and disturbance to all concerned.

One word of caution seems advisable. Care must be taken that during the process of passing the clamp through the urethra it is not allowed to open and release the end of the catheter. This

happened once during an operation by one of my assistants with the result that the entire catheter rapidly found its way into the bladder and had to be removed later with a lithotrite.

Experience has taught me that the perineal drainage is best established before the final steps in the primary operation are undertaken. Thus after an amputation of the penis, the catheter and clamp should be passed before the flaps of mucosa are sutured over the stump, in any of the various plastics the same principle will apply. At times the orifice of the urethra may have to be divided to admit the combined bulk of catheter and end of clamp.

While I have, perhaps unfortunately, kept no data as to the number of cases in which this procedure has been carried out, it is certainly close to one hundred if I include the operations done by my associates. It has been done not only in adults, but in very young boys with hypospadias. Nor have I a record of the number of patients on whom it has been performed more than once. In the case of amputation of the penis once is enough, where plastic operations have been done

for hypospadias a urethrotomy has been performed on each occasion twice in many, thrice in a somewhat smaller number and four times in a few. In no instance has there been the least difficulty in doing the urethrotomy nor has its repeated performance led to the immediate result of delay in closure of the urethral fistula nor to the remote result of stricture formation and many of these patients have been seen from time to time over a period of years.

The catheter is attached to a long drainage tube this being led into a large receptacle. It is kept in place until the sutures of the primary operation have been removed or until the chance of infecting the wound was remote.

After the catheter is removed it has been found that the perineal anus will close spontaneously in from 1 to 4 or 5 days after which time micturition becomes entirely normal and comfortable. In conclusion it seems important to state that hæmorrhage from the bulb has never been in the least troublesome nor so far as I can recall, has it failed to be controlled by the two transverse sutures which I have described.

THE NARROW BISPINOUS DIAMETER AND THE PERSISTENT OCCIPITOPOSTERIOR POSITION

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THE funnel pelvis, and particularly the ischial spines, have long been suspected as possible factors in the etiology of the persistent occipitoposterior position. As early as 1855 Sir James Y. Simpson stated that the spines of the ischia contribute far less (to rotation) than is generally believed. In 1896 Klien called attention to the frequent occurrence of the posterior position in funnel pelvis.

In the recent literature only an occasional reference to the subject is to be found. In 1916 Cragin stated "In the occipitoposterior position there is poor flexion, the occiput and sacrum reaching the pelvic floor at the same time and rotation is prevented by the spines of the ischia."

Harper more recently presented a similar opinion.

The views expressed in the literature, although covering a period of many decades, are vague and conflicting, and are based on personal impressions and not on statistical data. Careful consideration, however, shows that the subject deserves more than the cursory attention that it has received. The practical importance of the problem becomes apparent when it is recalled that the course of labor is most eventful at the level of the ischial spines, particularly in occipitoposterior positions. It is here that the cardinal movements of internal rotation and descent must occur simultaneously, while flexion must be maintained or re-established. These important events have never been investigated with reference to the narrow bispinous diameter. The object of the present study is, therefore, to determine what influence, if any, the narrow bispinous diameter may exert on the mechanism of labor, particularly in so far as the incidence of the persistent posterior position is concerned.

The work was undertaken in 1929 when a special pelvimeter for the measurement of the bispinous diameter became available (6). A preliminary report on the results obtained was presented in 1931 (7) before the Section on Obstetrics and Gynecology of the California Medical Association.

CLINICAL DATA

Observations were made on a series of 2,254 consecutive cases. 811 of these were primiparae. The bispinous diameter was measured in all of

these cases by the writer personally and all the operative deliveries were performed by him. The average measurement was found to be 10.51 centimeters. Pelvises with a bispinous diameter of 9.5 centimeters or less were rather arbitrarily classed as narrow and those measuring over 9.5 centimeters as normal or large. According to this classification there were 143 pelvises with a narrow bispinous diameter among the primiparae.

Positions were regarded as posterior when the occiput was found behind the transverse diameter of the pelvis at the time of delivery. However, cases in which partial rotation had occurred to occiput right or left transverse were also counted as posterior positions. The occiput posterior was considered as persistent when there was no progress in rotation or descent after efficient second stage pains continuing for a period of at least 2 hours in primiparae or 1 hour in multiparae after rupture of the membranes. Only cases in which the head was well engaged were included in the series, since the influence of the ischial spines cannot come into play unless the head descends down to the level of the narrow pelvic plane. Cases of persistent posterior position occurring in premature deliveries were excluded for obvious reasons. The commonly accepted standard, a birth weight of 2,500 grams or less, was considered as evidence of prematurity.

In attempting to classify the data obtained, it became apparent that in the interpretation of statistics bearing on the etiology of the persistent posterior position parity must be given first consideration. Confusion is unavoidable unless a clear distinction is drawn between primiparae and multiparae in all such discussions, and yet the subject has seldom been approached from this aspect even in the more elaborate statistical reports. Progress has undoubtedly been greatly retarded through this oversight.

In the present study attention will be focused on the occipitoposterior position in primiparae, since in multiparae the relaxed perineum is a complicating factor predisposing to the persistence of the posterior position.

Incidence in primiparae. A perusal of Table 1 shows that the bispinous diameter is narrow in 27 of 38 (71.0 per cent) of the cases of persistent

occipitoposterior position. The measurement exceeds 10.5 centimeters in only 1 of the 38 cases. These findings are even more striking when it is recalled that the narrow bispinous diameter occurs in only 17.67 per cent of the cases. The average measurement for the group is only 9.46 centimeters as compared with the normal of 10.51 centimeters.

Conversely there is an exceedingly high incidence of the persistent posterior position among this group of pelvis—27 among 143 cases (18.9 per cent). This is an incidence almost as high as that given in the recent literature (2, 5, 7, 10, 13) for unselected cases of the occipitoposterior position early in the first stage of labor and is approximately thirteen times greater than the incidence of the persistent posterior in the group of 668 primiparae with normal bispinous diameters.

Other pelvic measurements in primiparae. The sacropubic or anteroposterior diameter of the narrow pelvic plane was measured in 24 unselected cases of persistent occipitoposterior position. The average measurement was approximately normal in this series, although the bispinous diameter showed the usual degree of contraction.

The bischial diameter was found to be moderately narrow the average measurement being 9.00 centimeters (the average for the entire series was 10.70 centimeters). In 7 of the 27 cases, however, in which the bispinous diameter was narrow the bischial was normal or large. The bischial diameter is thus less frequently associated with the persistent posterior position than is the bispinous diameter.

The bischial diameter was sufficiently narrow in only 2 cases to form a probable obstacle to descent (Cases 22 and 6).

The other pelvic measurements were essentially negative with the exception of a moderate degree of general contraction in Cases 3, 7, 20, 26 and 30 and an oblique contraction (tuberculosus of hip) in Case 36.

Incidence in multiparae. Among 52 cases of persistent occipitoposterior position in multiparae in this series there were 18 cases with a narrow bispinous diameter an incidence of only 34.6 per cent.

INFLUENCE OF NARROW BISPINOUS DIAMETER ON OCCIPITOPOSTERIOR POSITION IN PRIMIPARAE

The data presented show that in this group there is a very frequent association between the persistent occipitoposterior position and the narrow bispinous diameter. This observation can be readily explained by a consideration of the mechanism of labor.

TABLE I—PERSISTENT OCCIPITOPOSTERIOR POSITION IN PRIMIPARAE

Case	Bischial diameter	Bispinous diameter	Weight in grams	Type of delivery
1	8	9.2	1577	Manual rotation and midforceps
2	8.5	9.1	2163	Manual rotation and midforceps
3	10	9.4	4144	Vaginal
4	9.5	9	4040	Manual rotation and midforceps
5	9.0	8.8	3000	Manual rotation and midforceps
6	9.3	9.3	2130	Manual rotation and midforceps
7	9.0	8.8	3577	Cesarean (occiput right transverse)
8	9.5	9.0	3045	Kielland midforceps
9	9.0	9.5	3068	Manual rotation and midforceps
10	8.5	9.5	3831	Manual rotation and midforceps
11	9.5	9.3	4550	Manual rotation and midforceps
12	9	9	347	Spontaneous (occipitosacral)
13	10.0	8.8	3068	Manual rotation and midforceps
14	8.5	9.0	3426	Spontaneous (occipitosacral)
15	8.5	9.3	2130	Spontaneous (occipitosacral)
16	8.5	9.0	4004	Manual rotation and midforceps
17	10.0	9.5	3804	Manual rotation and midforceps
18	9.0	9.0	3063	Kielland low forceps
19	10.3	9.3	3793	Kielland low forceps
20	9.0	8.8	3804	Manual rotation and midforceps (occiput right transverse)
21	8.5	8.5	377	Manual rotation and midforceps (st. of twins)
22	8.5	9.1	3718	Kielland low forceps
23	9	9	2363	Spontaneous (occipitosacral)
24	8	9	4001	Spontaneous (occipitosacral)
25	10	9	3780	Manual rotation and midforceps (occiput right transverse)
26	8.3	8.3	2360	Cesarean (occiput left transverse)
27	9.5	9.1	4020	Manual rotation and midforceps
28	9.3	9	2740	Spontaneous (occipitosacral)
29	8.6	8.6	2210	Spontaneous (occipitosacral)
30	8.6	8.6	3.80	Kielland midforceps
31	10.3	9.3	2300	Manual rotation and midforceps
32	9.5	9.0	2540	Manual rotation and midforceps
33	9.3	9.9	3000	Spontaneous (occipitosacral)
34	9.1	8.8	3401	Spontaneous (occipitosacral)
35	8	8	5.00	Low forceps (occipitosacral)
36	11.5	9.4	3870	Low forceps (occipitosacral)
37	9.5	9.0	41	Low forceps (occipitosacral)
38	9.5	9.3	3.70	Spontaneous (occipitosacral)
Average	9.00	9.46	2350	

Deflexion is generally considered one of the most important factors in the etiology of the persistent posterior position. The maintenance of flexion, of course depends on the circumstance that the forces acting against the sinciput must overbalance those exerted against the occiput. Accordingly, any factor that increases the resistance which the occiput encounters, tends to favor deflexion. It seems that a narrowing of the bispinous diameter would have just this effect of causing obstruction to the advance of the occiput, with deflexion as an inevitable consequence. Aside from this effect on flexion the narrow bispinous diameter would tend to hinder rotation directly by offering increased resistance to the presenting part which as a result of the deflexion, is considerably larger and more rounded than spherical, approaching the suboccipitofrontal plane in both size and contour. Descent would likewise be obstructed due to the contraction of the bispinous diameter and the general increase in the plane of the presenting part. Furthermore due to the insufficiency in descent, the presenting part may not come into intimate contact with the pelvic floor. The favorable influence of the levator ani muscles on rotation would, therefore, remain in abeyance, and the sole advantage of primiparity would thus be lost. These complications would be apt particularly to develop under the circumstances of weak pains and great soft tissue rigidity as in elderly primiparae. A dead lock thus results—descent is obstructed because of the persistence of the posterior position coupled with the deflexion attitude while rotation comes to a standstill due to the arrest in descent. In other words, a vicious cycle is established: there is no rotation without descent, and no descent without rotation or flexion. An escape from this vicious cycle is unlikely in primiparae, since the powers are seldom equal to the task of overcoming the soft tissue rigidity plus the bony resistance offered by a narrow bispinous diameter. All progress therefore ceases, with the head in a deep posterior or transverse arrest. From the foregoing discussion it is apparent that, in occipitoposterior positions, the narrow bispinous diameter may exert a serious disturbing influence on the mechanism of labor directly obstructing all three of the movements occurring in the lower midpelvis, namely, flexion, rotation and descent. In view of these considerations the persistence of the posterior position in pelvis with a narrow bispinous diameter is readily accountable.

The high incidence of the narrow bischial diameter in cases of persistent occipitoposterior position is a complicating factor that must be taken

into account. The common association of the narrow bischial diameter with these cases is to be expected, since there is a certain parallelism between the width of the bischial and bispinous diameters. It seems that the narrow bischial diameter cannot interfere with rotation when the largest plane of the presenting part is at the level of the spines or higher. Furthermore, the ischial tuberosities are situated too far anteriorly and at too low a level to cause deflexion, or directly to oppose rotation, even when the head is at the outlet. However when the station of the head is low an associated narrow bischial diameter may well be more than a mere coincidence since under these circumstances it may indirectly form an obstacle to rotation by causing obstruction to descent. It seems, therefore, that any inhibiting effect which the narrow bischial diameter may exert on rotation would largely be only secondary or accessory to the influence of the factors responsible for the persistence of the posterior position at the level of the spines.

Recently Thoms made the observation that in pelvis with transverse contractions of the inlet, engagement occurs almost invariably in the occipitoposterior position. This finding is important, but it has little direct bearing on the present study since it does not explain the persistence of the posterior position at lower levels of the pelvis, a subject with which the present work is particularly concerned.

INFLUENCE OF NARROW BISPINOUS DIAMETER ON OCCIPITOPOSTERIOR POSITION IN MULTIPARE

The lower incidence of the narrow bispinous diameter among cases of persistent posterior position in multiparae is probably due to the relaxed perineum. This is a complicating factor which, of course, predisposes to the persistence of the posterior position regardless of the width of the bispinous diameter and thus causes a relative decrease in the incidence of the narrow bispinous diameter among this group of cases.

PRACTICAL BEARING ON TREATMENT

In view of the fact that spontaneous anterior rotation occurs in the majority of cases, the conventional attitude toward the occipitoposterior position is one of "watchful expectancy." A policy of non-interference is generally recommended until operative intervention becomes urgent for the relief of "maternal exhaustion" or "fetal distress." The reward for such conservatism is spontaneous anterior rotation in more than 80 per cent of the cases. Unfortunately however the patients in the remaining smaller group, in

whom the occiput fails to rotate, are little benefited by the delay thus occasioned. In fact, positive harm comes in these cases of persistent posterior position through an undue prolongation of the second stage, since the malposition becomes less amenable to correction due to caput formation, excessive moulding and increased deflexion, as well as uterine spasticity and the tendency to the formation of a contraction ring. Version also becomes very hazardous or altogether impossible. These difficulties and dangers are multiplied by other well known ill effects of an unduly protracted second stage viz. added suffering exhaustion, tendency to postpartum hemorrhage and possible intracranial injury to the fetus.

Certain writers, particularly Bill and his followers, have been so impressed with the frequency and seriousness of the complications named as to advocate active treatment early in the second stage in practically all cases of the occipitoposterior position. Such a course of management would however entail an unjustifiably high incidence of operative interference with its attendant increase in morbidity and mortality. On the other hand the purely expectant treatment would best serve only the interests of the group of cases in which spontaneous rotation ultimately occurs, but would be decidedly detrimental to the cases of persistent posterior position.

In occipitoposterior positions complicating labor in elderly primiparae, or in borderline cases of disproportion, cesarean section may come up for consideration. In such cases the posterior position, if persistent, may well be a factor of decisive importance in favor of section. It is therefore imperative that the persistence of the malposition be anticipated early in labor—before abdominal delivery becomes contra indicated.

In view of these considerations it becomes highly desirable for purposes of rational treatment to find means of differentiating early in labor the cases which are most likely to remain in the posterior position from those in which the outlook is good for spontaneous anterior rotation. This differentiation is now greatly facilitated with the ready means available for the measurement of the bispinous diameter and with the knowledge that anterior rotation takes place relatively infrequently in pelvis with a narrow bispinous diameter, but does occur as a rule in pelvis with a normal or large measurement. This, as already intimated, applies chiefly to primiparae. In multiparae the width of the bispinous diameter does not bear a sufficiently constant relationship to the posterior position to be of much value as a guide in treatment.

From the evidence presented it follows that in primiparae in whom the bispinous diameter is narrow it may be permissible for practical purposes to consider cases of posterior position as persistent, if rotation fails to occur after a brief test of the second stage. Early intervention, under such circumstances, will eliminate what would otherwise be in most of these cases, a long and futile second stage, with its attendant difficulties and disastrous complications. Where as in the group of primiparae in whom the bispinous diameter is normal or large, an ultraconservative course may be followed with full confidence that anterior rotation will occur spontaneously in the great majority of the cases unless there is either uterine inertia or marked disproportion.

It seems that the above basis for selective treatment should give better results than a rather arbitrary policy of purely expectant or very radical management. However, a final appraisal of the merits of the plan proposed must come from a comparative analysis of the incidence of the morbidity and mortality in large series of cases treated by the methods under consideration.

SUMMARY

In a series of 143 primiparae in whom the bispinous diameter was found to be narrow there were 27 cases (18.9 per cent) of persistent occipitoposterior position. This incidence is approximately thirteen times greater than the incidence of the persistent posterior position in pelvis with a normal bispinous diameter. The persistence of a posterior position may therefore be anticipated early in labor if the bispinous diameter is narrow and operative intervention may be instituted under the most favorable circumstances.

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PLACENTA PRÆVIA

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THE avoidable maternal mortality from placenta previa throughout the civilized world, as shown by recent surveys, emphasizes again the grave lack of knowledge of the fundamentals in the care and treatment of this condition by those attending the pregnant woman.

Quoting from "Maternal Mortality in New York City" in which a group of physicians have carefully outlined the factors involved, we find these conclusions: "It is evident that the prenatal course of these women was improperly supervised either through their own ignorance in disregarding what seemed to be trivial bleeding, or through the failure of the attendant to evaluate the symptoms and institute proper treatment. The frequency with which the patient was neglected even after a really significant hemorrhage which pointed most emphatically to the existence of placenta previa, is an indication that the gravity of the situation was only poorly grasped by the attendants. It is vital that the attendant inform the patient categorically that bleeding during pregnancy is never trivial and may be and often is the warning of disaster. Furthermore, the treatment in these cases was frequently improper. The choice of operation as well as the time of its performance must be judicious. Rapid traumatizing delivery by the birth canal must be avoided as it increases the hazard to the mother."

Of 7,537 obstetrical deaths in 15 states during the years 1927 and 1928 studied by the Children's Bureau of the Department of Labor, there were 408 who had placenta previa. Of these 408 cases 347 deaths were directly due to placenta previa while 61 were also complicated by sepsis. 339 women were reported to have had delayed treatment, the delay being due to the doctor in 129 cases and due to the patient, family or circumstances in 110 cases.

Fifty-two per cent of these 408 cases were delivered by podalic version and extraction, 10 per cent by cesarean section, 8 per cent by forceps, 4 per cent by manual dilatation of the cervix, and 7 per cent by other operative means. There seemed to be considerable misunderstanding on the part of the doctors regarding the dangers of version and extraction with immediate delivery and the Braxton Hicks maneuver with delayed extraction. As a matter of fact, the latter was

rarely done. Rupture of the uterus, tears, hemorrhage and shock were frequent. So large a number died immediately after delivery that relatively few lived long enough to die of sepsis. The treatment of shock and hemorrhage was conspicuous by its almost entire absence. Fluids of any sort were rarely used. That the buttocks of the child could be used to control hemorrhage and that shock could be treated at this time was practically never considered. Cesarean sections were often done without any effort being made to combat the patient's shock.

Such a report emphasizes the grave lack of knowledge of cardinal obstetrical principles by a large number of doctors attending the parturient woman.

The statistics reported in this paper are primarily from the Chicago Lying-in Hospital since its affiliation with the Department of Obstetrics and Gynecology of the University of Chicago 23½ years ago. Included are also the statistics from such cases in the 4 years previous to the old Chicago Lying-in Hospital.

The incidence of this pathological condition has been 1 in 115 cases delivered in the hospital. Only cases in which the placenta was palpated or seen covering, partially covering or bordering on the internal os are included. No cases of low implantation have been included. Placenta previa totalis is the terminology used for any case in which the internal os is completely covered with placental tissue when the patient is examined. Partialis and marginalis describe those cases in which the internal os is partially covered or bordered by the placenta.

Patients who are bleeding or have a history of bleeding who are seen in their homes by the internes of the home service department, are transferred to the hospital immediately without rectal or vaginal examination being made. Prospective donors among the family and friends accompany her.

Any patient 30 weeks or more pregnant admitted bleeding vaginally or with a history of vaginal bleeding is immediately prepared for sterile vaginal examination. Typing of the patient's blood and cross matching with available donors is done while the operating room staff sterilizes bags for intra-uterine insertion should they be needed. Instruments for cesarean section

are always in readiness. If the patient is in shock, appropriate medication, heat and subcutaneous or intravenous fluids, are immediately given. Although only 10 to 20 per cent of the cases so examined prove to have placenta prævia or abruptio placentæ, nevertheless the same rigid routine is followed for each case. The patient primarily presenting the least symptoms may prove to be the most serious emergency when examined.

Combating shock and hæmorrhage by means of blood transfusion and the administration of fluids, before or during delivery, in the patients who have had any blood loss is as important as the method of delivery chosen. In emergency cases a well trained operating and transfusion team have to function almost simultaneously.

Dieckmann has used 30 cubic centimeters of a 30 per cent solution of sodium citrate administered intramuscularly or 15 cubic centimeters intravenously as had been found by Neubof and Hirschfeld to shorten the coagulation time and thus prevent blood loss.

Before the methods of delivery are discussed it should be recalled that there is no standard form of treatment for all cases. In a patient with a living viable fetus if the vaginal examination reveals the cervix partially dilated with effacement and the placenta marginally situated rupture of the membranes allowing the head to come down acting as a compressor may be sufficient treatment. Otherwise the insertion of a bag will control the bleeding or the fetal scalp may be grasped with the Willett forceps and traction applied.

There are a few cases with previable or al ready dead infants where the cervix is only slightly dilated that the intraovular introduction of a bag or a Braxton Hicks version with delayed extraction may be done. Kerr found that the bag had a very limited usefulness in the treatment of placenta prævia. Occasionally a patient's cervix will be completely dilated or dilatable when first examined allowing a version and extraction or forceps delivery if spontaneous delivery is not imminent. If a Braxton Hicks maneuver has been decided upon one may attempt, first, an external version bringing a foot over the cervix thus preventing the dangers of an intra uterine insertion of the hand causing separation of the placenta.

McPherson advocates tamponading the cervix with iodoform gauze strips where the child is dead or non viable when the cervix becomes sufficiently dilated the child is extracted in the manner chosen by the operator. It should be remembered that, as Kerr states, 'all statistics go to prove that

TABLE I.—TREATMENT AND RESULTS

January 1927 to May 1931		Seventy-two cases
Type of placenta prævia.		Cases
Marginalis		30
Partialis		31
Totalis		17
Methods of treatment		
Low cervical cesarean section		26
Porto cesarean section		5
Vaginal cesarean section		1
Braxton Hicks		1
Rhesus extraction		2
Forceps		1
Spontaneous		16
Results		
Maternal mortality		None
Fetuses lost		21
Not-viable dead on admission or monsters (below 1,000 grams)		9
Viable and living on admission		23
Total fetal mortality per cent.		41
Corrected fetal mortality per cent.		70.7
May 1931 to January 1934		Sixty-three cases
Type of placenta prævia.		
Marginalis		32
Partialis		0
Totalis		31
Methods of treatment		
Marginalis—		
Spontaneous rupture of membranes		9
Insertion of bag		4
Braxton Hicks		1
Low cervical cesarean section		7
Partialis—		
Spontaneous rupture of membranes		0
Insertion of bag		3
Braxton Hicks		3
Low cervical cesarean section		2
Porto cesarean section		1
Totalis—		
Spontaneous rupture of membranes		0
Insertion of bag		3
Braxton Hicks		3
Low cervical cesarean section		21
Porto cesarean section		3
Results		
Maternal mortality		None
Fetuses lost		14
Dead on admission (below 1,000 grams)		3
Dead within 24 hours of delivery (1,000 to 2,500 grams)		4
Dead (below 1,000 grams)		7
Total fetal mortality per cent.		74.3
Corrected for those dead on admission and those weighing 1,000 grams per cent.		63
Average age of patients, years		30.7
Primiparæ, cases		28
Multiparæ, cases		35
Average antepartum blood loss, c cm		200
Average intrapartum blood loss, c cm		500
Total blood loss		700
Number of patients having blood transfusions		13
Percentage		20.6
Weeks pregnant		
20 to 30 weeks		5
30 to 35 weeks		7
35 to 40 weeks		21
40 or more weeks		17

packing of the cervix in placenta prævia adds materially to the mortality and morbidity rates unless it is carried out under the strictest antiseptic precautions.'

Ligation of the uterine arteries through the vagina as described by Miller in 1907 and Kerwin in 1926 might well be a life saving procedure in an emergency when facilities for an immediate operation are not available. Henkel's clamps for the broad ligaments may also be used.

Any patient diagnosed as having a placenta prævia with an uneffaced rigid cervix and practi-

TABLE II

Author	N. of cases	Year of report	Predominating method of treatment	Maternal mortality	Fetal mortality gross	Fetal mortality corrected
Kern-Miller Lund	121	1911	13 spontaneous or rupture of membranes 17 Braxton Hicks 6 Cesarean-section 7 Cesarean + hysterectomy	17	45.6	
Monowits Jewish Maternity New York	18	1909-1910	Rog and Braxton Hicks mostly	7.5	47.7	1.6
Seigel University of Maryland	112	1910-1910	Cesarean section and Braxton Hicks	6.43	44.86	31.6
Kellogg Barnes Lying-in Hosp	151	1903-1911	Rog and Braxton Hicks	8.6	34	
Kellogg Barnes Lying-in Hosp	96	1911-1910	Cesarean section	1.06	31.7	
Living Personal Cases	67		Rog and Braxton Hicks	3.1	57.9	45
Woodward and Langrock Hudson Hosp New York	101		Mostly Braxton Hicks	10.9	66.6	
Parkman Jules Hopkins Hospital	146	1908-1910	Mostly bog	10.96 8.64 for post. 30-375	67.51	33.71
Rotunda Hospital	100	1907-1911	Mostly Braxton Hicks	9	33	
Group of Five Large British Hospitals	1081	1905-1910		8		
Ell Cleveland	104	1902-1910	38 per cent by cesarean section	9.1	30.96	
Chicago Lying-in Hospital	96	1907-1911	30 per cent by cesarean section		41	10.7
Doyle, O'Neil & O'Neil City of Chicago	61	1901-1910	54 per cent by cesarean section			6.3
	20					

cally all cases of placenta previa totalis, if in a hospital in competent hands should be delivered abdominally as the danger of hemorrhage intra partum and postpartum is much greater than the mortality from cesarean section. The advent of cesarean section in the treatment of placenta previa has not only materially lowered the maternal mortality but has almost eliminated deaths of viable babies that were living when the patient was examined. Whereas the gross fetal mortality was formerly 60 to 80 per cent, it is now as low as 22 per cent.

In this clinic the low cervical cesarean section with routine packing of the uterine cavity is used and has proved most satisfactory.

In Table I are shown the various methods of treatment employed for each type of placenta previa. The results in this clinic, 139 consecutive cases over a period of 7 years, without maternal mortality emphasize the necessity of individualizing each case and of such extreme caution in the preliminary examinations and pre-operative care. *There have been no corrections in the maternal mortality.* The gross fetal mortality includes all fetal deaths no matter what the weight or whether they were monsters or stillborn. The

corrected fetal mortality eliminates fetuses under 1,500 grams in weight, those stillborn on admission, and monsters (Table I).

The results obtained from a few comparable series of cases of placenta previa have been abstracted from a large amount of material on this subject and are presented here for comparison. The best results have come from hospitals where cesarean section is the predominating method of treatment or the cases were handled by a single skilled individual, with the notable exception of the Rotunda in Dublin where the Braxton Hicks maneuver is the preferred treatment in most cases (Table II).

CONCLUSIONS

1. The maternal mortality from placenta previa in a well equipped maternity hospital should approach very closely to zero.

2. The corrected fetal and neonatal mortality from placenta previa can be materially reduced under ideal conditions and is now approximating the fetal and neonatal death rate from other causes.

3. The high maternal mortality from placenta previa over the country as a whole is largely due

to carelessness or ignorance of the patient's physician or to inadequate facilities for proper maternal care.

Since this paper was written there have been 16 additional cases treated in this clinic without maternal mortality.

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CORRESPONDENCE

EARLY AMERICAN HOSPITALS—'OLD BLOCKLEY

THE following are excerpts from a letter which we have received from John N. Hatfield, superintendent Pennsylvania Hospital in reference to the article by Dr. Temple Fay on Old Blockley published in the April 1934 issue of *SURGICAL GYNECOLOGY AND OBSTETRICS* pp 797-804

To the Editor. Our attention has been called to the article regarding Old Blockley by Dr. Fay and we are constrained, in the interests of accuracy to call attention to certain source material which establishes the priority of the Pennsylvania Hospital in the hospital field.

Dr. Fay makes the statement, p 797 that Blockley is the first organized unit for the care of the sick and needy to be founded on the American continent and offers many interesting dates, references, specific and general statements in support. Let me say here that the Pennsylvania Hospital claims to be the oldest hospital founded as such in the British Colonies in North America. This claim is based on authentic historical source material now in our archives.

I will take up several of the references and statements in the order in which they occur in Dr. Fay's interesting article.

1. p. 797—reference to the Friends Almshouse, 1712 and the legislative loan for an Almshouse or Hospice in 1729. The Friends Almshouse was established by the Society of Friends and was in no sense a city institution—see any standard work on early Philadelphia History.

2. p. 798—statement, Pennsylvania Hospital was founded in 1753. Application for a charter for the Pennsylvania Hospital was read before the Provincial Assembly on January 23, 1751. This application while first mentioning the insane also enumerates other diseases to be treated thus clearly establishing the intention to open a general hospital. This paper is in our archives today. Organization was completed May 1, 1751 and applications for admission of patients first received February 20, 1752 at which time the Overseers of the Poor asked admission for their inmates (1st minute book, p. 22)

3. p. 798—general statement to show early clinical instruction at Blockley

4. p. 800—the first ward instruction. Clinical teaching and ward instruction are so interwoven that I comment on these two references as one. Teaching by members of the staff and on the wards of the Pennsylvania Hospital as early as 1762 is shown by the managers' minute books from which I excerpt the following

p. 327—2nd minute book—9th 11th mo. 1762

Adjourned meeting of the Board to open 3 cases of anatomical paintings and casts sent by Dr. Fothergill for Dr. Shippen's use in instructing students—"And if any professor of anatomy is desirous to exhibit Lectures he is to apply to them (the Managers) for Liberty. All such Pupils as attend the said Lectures intended to be exhibited by Dr. Shippen or any other Person should pay a Patoles each."

p. 372—2nd minute book—10th 5 mo. 1763

And it being remarked that a number of students in Physic do frequently attend the wards at the time of the Physicians visiting the Patients with a view to improve themselves in experience, it is the unanimous opinion of the board that such of them at least

who are not apprentices to the Physicians of the House—should pay a proper Gratuity for the Benefit of the Hospital for their services, the consideration of Stipulating the same is referred to the next board for consulting with the Physicians

p 373—2nd minute book—The Board met with Dr Wm Shippen, Jr 17th 5th mo 1763 and agreed that he should use the paintings for a lecture to any interested persons once a fortnight during that summer

p 278—3rd minute book—A special meeting of the board and the physicians was held at the home of Dr Thomas Bond who

Read in our presence an Essay on the Utility of Clinical Lectures, and a plan for executing the same for the benefit of Students in Physic, and promoting the purposes of this Institution as follows

The minutes note the lecture was given in the hospital December 3 1766

p 798—statement to show probable origin in "Blockley in 1774 of gratuitous professional service to the public confined to charitable institutions

p 14—1st minute book—33rd 10th mo 1751

The Board were acquainted that Dr Lloyd Zachary Dr Thomas and Phoenix Bond were willing to give their Attendance gratis in taking care of the Sick in Physicians and Surgeons for the first three years, the President is desired to give them the Thanks of the Board for their generous offer and to request Drs Graeme, Cadwalader Moore, and Robinson to assist in Comedica from an extraordinary Cause.

This arrangement continues today

p 84—1st minute book—The summary of the first year's work shows 54 admissions to the hospital between February 11 1752 and February 10, 1753 and of these 28 paid sums ranging from 15 shillings for a stay of 10 days to £18 18 4 for a stay of 7 mo 23 days, the remaining 36 paid nothing at all.

p 800—statement of establishment of out door medical relief.

p 16—1st minute book Board meeting of 2nd of 4th month, 1751

A dropical person apply'd as a Patient but having the Itch was admitted as an Out Patient at the Expense of the hospital for two Weeks

p 67—1st minute book Board meeting of 4th of the 1 mo 1753

John Small was admitted on the 13th (of December, 1753) to be treated as an out-patient, his Case a periodical Madness and the Medicine of the Hospital was allow'd to be administered to Mary Barton an out Patient

Bear in mind that all of these patients were sick, either mentally or physically when admitted and were admitted for the express purpose of having a cure effected—in no case was the admission based on poverty or dependency

p 800—establishment of residtability in 1788

Residents at the Pennsylvania were appointed in the early days as shown by the following

p 66—1st minute book—13th of 12 mo 1752.

Agreed that an Apothecary be employ'd to prepare & compound the Medicines and Administer them Agreeable to the Prescrip-

tions of the Physicians & Surgeons and that he shall give Bond with Sureties to the Managers for the faith (of performance of his Duty

p 354—4th minute book—shows the appointment of the first medical apprentice (interns)—Board meeting of the 26th 7 mo 1773

Joseph Ehrenmacher Junior indentured to serve 5 years and 3 months being executed on the 1st of last month in the presence of his Father and Samuel Coates, was now produced and read, and deposited with other papers by the Clerk, the Terms agreed on with his Father, besides what is generally expressed in the Indenture as follows, viz That he shall have leave to his own or his Father's Expense to attend the Lectures of the Medical Professors out of the Hospital during the two last years of his apprenticeship, to attend the Surgical operations and lectures in the Hospital free of any Expense, and that the Apothecary for the time being shall duly instruct him in Physic and surgery

8 p 808—statement by the Poor Board in 1805 that Pennsylvania Hospital charged more than an equivalent for board and lodging

9 p 801—statement of rivalry between the two institutions in 1813

Here again the subjects are so related, I treat them as one

p 217—5th minute book—Board meeting 28th 6th mo 1781

The managers of the House of Employment & The Overseers of the Poor Mrs John Cassanuga, Steward of said house, request that Paupers may be occasionally admitted into the Hospital as poor Patients, at the rate of a Sixty and All'd Dollar per a week—to which the board agreed at the rate of a dollar & one third, and apiece

p 324—6th minute book—meeting of 28th 2 mo 1791—ult having been entered, a verdict was secured for "one thousand and fourteen pounds due to the 24th of February 1790 for care of patients from the Almshouse

p 431—7th minute book—12th mo 19th 1801

The Committee appointed to prepare proposals to be offered to the Managers of the Alms House for the Board of pay patients report—That they have carefully examined the household expenses and find that in 1800 the weekly cost of patient in the Pennsylvania Hospital was 20q and in 1810 was 21 cents the average of those two years was 20c cents p week Considering that the price of provisions and other necessary articles of living will probably be reduced in the next year on account of the late peace between England and France etc and that further sum will probably be saved by admitting a larger number of patients inasmuch as wages, etc will not be increased in the same ratio as patients are multiplied, your committee think it will be able to lower the terms of admission to the Guardians of the Poor and therefore they submit to the board the propriety of adopting the following resolutions—1st—Resolved, that the Managers of the Hospital will take from the Managers of the Alms House all such pay patients as the Hospital physicians consider as proper cases to be received therein at 2 q cents p week, and—Resolved, that all their pay patients who are now in the house shall be charged at the same price 3rd—Resolved, that the accounts shall be settled at the end of every 3 months 4th—Resolved, that if the foregoing proposals are not agreed to, the terms of admission shall not be altered from three dollars a week until further order is taken thereon The Committee report being considered & approved and they are requested to furnish the managers of the Alms House with copy of the foregoing resolutions which the board will confirm—provided the physicians of the Hospital will agree to them and provided the answer to be sent to the Hospital shall not at any time exceed what in the opinion of the Managers the house will conveniently and comfortably accommodate

p 433—7th minute book—meeting of 1st mo 1780—The Almshouse Board did not accept the offer they suggested the Pennsylvania Board adopt this resolution—

Resolved that the Managers of the Pennsylvania Hospital will take from the Managers of the Alma House, all their lunatics and such other pay patients as may be considered curable cases and proper for admission into the said hospital (agreeably to its rules) at 25 cents p. week for each of them for one year. The Almshouse Committee also propose to the Managers of the Pennsylvania Hospital that they shall cease to be attended all their patients who may be in the Almshouse by the Hospital physicians, gratis, and that they shall be supplied with medicines except liquors at the expense of the Hospital

The Hospital Board agreed to these changes (p 434—7th minute book) but the Almshouse Board decided not to enter into the agreement (p 435)

In 1815 (p 241—8th minute book) the medical students of the Pennsylvania Hospital were invited to attend the surgical operations which may here after be performed in this House (the almshouse.)

Today professional men hold appointments on the staff of the Pennsylvania Hospital and on that of the Philadelphia General Hospital paralleling a like condition when in the early days the outstanding men of the times held appointments on the Pennsylvania Hospital staff and were also attached to the Almshouse, probably for the same reason that today any institution having an infirmary for the care of its own people has a physician on call

To interpret these bits of history correctly we must consider them in relation to the general economic and political conditions of the period. Viewed in this light I am much impressed with the thought that the period between 1781 and 1815 possibly marks the emergence of the bona fide Philadelphia Hospital from the Almshouse Infirmary. The minutes above quoted constitute a very small portion of a voluminous correspondence between the almshouse and the hospital boards on the subject of taking patients from the almshouse into the hospital. The amounts of money involved, at the very low weekly rates, indicate a large number of these patients. We know from history in general that the city was growing at the time, and economic conditions were difficult and uncertain following the Revolutionary War. The urge toward civic growth and the inherent reluctance of the individual to accept change probably combined to exert uncomfortable pressure on the almshouse board, resulting in the hostile attitude which Dr. Fay states they showed toward the res-

idly developing medical profession. They could not escape the need for greater medical facilities than their infirmary offered but—close at hand was a well established hospital—it would be easier financially and administratively, to establish relationships which eventually could lead to amalgamation than to develop a hospital department of their own but the hospital managers did not take kindly to dictation. They had started out to achieve a certain object and were not any more inclined to change that objective than the almshouse managers were.

10 p 802—reference to library

The Pennsylvania Hospital medical library claims to be the first public medical library in the United States having been founded in the following manner as shown by the minute books —

p. 314—2nd minute book—27th 7 mo 1762—

William Logan lately returned from London attended the Board with a Book intitled "An Experimental History of the Materia Medica by Wm. Lewis F.R.S." lately published in London being a Present to the Hospital by Do^r John Fothergill for the Benefit of the Young Students in Physic who may attend under the Direction of the Physicians w^{ch} is kindly accepted by the Managers as an additional Mark of the Doctor's regard to this Institution and W Logan is requested to acquaint him wth our grateful Acceptance thereof.

p 378—2nd minute book—31st 5th mo 1763—The Physicians agree that students receiving ward instruction should pay a fee and these fees should be applied

to the founding a Medical Library in the said Hospital which we judge will tend greatly to the Advantage of the Pupils & the Honour of the Institution.

The first catalogue of the library was issued in 1790—listing 538 volumes. The catalogue of 1837 showed 7300 volumes and in 1856 the number had grown to 10 500. While our library contains many rare and valuable works on medicine and natural history and has grown by several thousand volumes since the 1856 catalog it has not maintained its activity since the establishment of the splendid library of the College of Physicians in Philadelphia.

11 p 804—reference to members of the staff.

Morgan Shippen, Jr., Kuhn, and Rush all practiced and taught in the wards of the Pennsylvania Hospital, in the archives of which are to be found many interesting references to and documents signed by them

Interested members of the profession and students of history are cordially invited to go through the historic section of the Pennsylvania Hospital.

Philadelphia

JOHN N. HATFIELD

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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OBSTETRICAL ANALGESIA AND ANÆSTHESIA

IN no country have methods for the relief of the pain of labor or parturition been so extensively employed or so widely discussed both in medical journals and in lay magazines as in the United States. For purposes of clarity it is proper to define the terms ordinarily used to describe various phases of relief of pain in obstetrics. The term *amnesia* indicates forgetfulness of pain; *analgesia* commonly refers to dulling the sense of pain and *anesthesia*, to local or general insensibility to pain. It may be recalled, also, that more than one of these phases may be produced by the same drug or combination of drugs depending on the dosage and method of administration.

The risk of *anesthesia*, which is not great, falls chiefly on the mother. This risk is known to depend on her physical condition, on the anesthetic agent, on the technique of its use, and on the degree of *anesthesia*. Drugs used to produce *amnesia* and *analgesia* are seemingly more dangerous to the fetus. Apparently too little thought is sometimes given to

the indirect effect of measures to relieve the pain of labor as is apparent from the growth in the number of operative deliveries and the increased risk that accompanies these procedures. In a recent publication by the New York Academy of Medicine of the analysis of maternal deaths occurring in the city of New York in a period of 3 years, 1930 to 1932, inclusive comment was made on the relationship of obstetrical anesthesia to maternal and fetal mortality. In this report it was stated that the increased use of anesthesia in labor was due to insistence of the lay public, that in addition to deaths directly attributable to anesthesia the use of anesthesia was a factor in keeping the maternal mortality rate in this country stationary during the previous decade and that both the accessibility of anesthesia and the lessening of expulsive power resulting from its use led to frequent operative deliveries to which many maternal and fetal deaths can be attributed. These investigators assumed that ether is the safest anesthetic agent if one must be given, and that a derivative of barbituric acid (*pernocton*) tri-bromethylalcohol (*avertin*) and spinal anesthesia are entirely unsuitable for the parturient woman.

In favor of anesthesia as it has been used in the second stage of labor since the introduction of chloroform and ether and more recently of nitrous oxide and oxygen it may be said that anesthesia relieves the woman in labor of part or all of the severe pain of the second stage that the relief of pain tends to prevent nervous fatigue and its attendant shock and that operative measures, when indicated, can be carried out more easily and

skillfully. Space does not permit consideration of the relative merits and dangers of ether, chloroform and nitrous oxide and oxygen. It is generally conceded that the use of ether presents a combination of relative safety, cheapness and simplicity of administration that as yet is unsurpassed. Chloroform possesses the last two requisites but has a smaller margin of safety. Nitrous oxide and oxygen, a more expensive anaesthesia requiring greater skill in administration, can be administered under hospital conditions with a minimal amount of risk to mother and to child, if one always, "keeps the patient pink," as Lundy has concisely stated it. Spinal anaesthesia which has been advocated for operative obstetrics because it produces loss of sensation and excellent relaxation of the cervix and pelvic floor carries more risk for pregnant than for non pregnant persons. Caudal, sacral, and parasacral anaesthetics are practically without risk but they as well as infiltration anaesthesia of the cervix and pelvic floor, can hardly come into general practice on account of the technical skill required in their administration.

Amnesia and analgesia were unfamiliar terms up to twenty years ago although drugs such as morphine, chloral, paraldehyde and alcoholic beverages had been used as analgesics. At that time, the administration of morphine and scopolamine during labor popularly known as "twilight sleep" following the report by Koenig and Gauss was tried extensively, but this method of producing amnesia and analgesia has been discontinued except by a few skilled obstetricians who have special hospital arrangements and trained attendants. The statement that the routine use of morphine during labor is followed by a higher incidence of fetal asphyxia as attested by Baer, Piper, Plass, Irving and by others has not been successfully contradicted. Max

well stated of the use of scopolamine that one in four patients is refractory to the drug, and that it prolongs the second stage of labor leading to increased operative interference.

Other analgesic agents have appeared including avertin, pernocton, other derivatives of barbituric acid, and the Gwathmey method of colonic ether-oil analgesia. Avertin, which must be used rectally, and pernocton and the barbituric acid derivatives when used intravenously have the common fault that patients may be susceptible to them, this cannot be guarded against, owing to the rapid and uncontrolled effect of rectal absorption and of intravenous medication and the narrow margin of safety when actual anaesthesia is produced.

Gwathmey oil-ether colonic analgesia has been rather widely used. Tovell lists as possible complications rectal irritation (which need not occur if there is no rectal disease or if it is properly given), arrested labor, ether shock, and asphyxia neonatorum. To these may be added the risk of tissue slough if the accompanying solution of magnesium sulphate fails to be injected into the muscle together with the increased incidence of instrumental delivery. It has distinct value in prolonged labors especially in primiparae with the occiput in the posterior position. The method is inexpensive and can be employed either in the home or in the hospital by those who are trained to its use.

Irving and his coworkers have recently published the results of the use of eight different combinations of hypnotics in the production of anaesthesia during labor. The drugs used were (1) an opium derivative (pantopon) and scopolamine, (2) pantopon and rectal ether, (3) pernocton, (4) sodium amytal and scopolamine, (5) pentobarbital sodium and scopolamine, (6) sodium amytal and rectal ether, (7) pentobarbital sodium and

rectal ether, and (8) pentobarbital sodium and paraldehyde. Each combination was administered in a dosage aimed to produce complete amnesia in eight series of 100 patients each, in which no major abnormality on admission to the hospital was presented.

In commenting on the effects of these drugs, the authors advised against the use of morphine and its derivatives during labor as it distinctly delayed the initial respiration of the child. There was delayed respiration varying from 35 per cent in the group of infants whose mothers had received pentobarbital sodium and ether by rectum to 67 per cent in those infants whose mothers had received pantopon and scopolamine. In the out patient department in a control series of cases in which delivery was without anesthesia, only 19 per cent of infants did not breathe spontaneously at birth. The delayed respiration in the total series of 860 babies however did not increase the stillbirth rate which was only 0.93 per cent.

In conclusion Irving and his coworkers stated that they believed the combination of pentobarbital sodium and scopolamine was the most effective method. 86 per cent of the patients who received these drugs had complete amnesia. 83 per cent did not exhibit excitement and 63 per cent of the infants breathed immediately on birth. In this group however the incidence of operative deliveries was 47 per cent in primiparae and 30 per cent in multiparae. Independently Moore had reached a similar conclusion regarding the use of pentobarbital sodium and scopolamine to produce analgesia in labor.

If an analgesic is to be used it is suggested that one of the safest forms of analgesia known at present is that obtained by the oral administration of sodium amytal or pentobarbital sodium although the latter seems preferable because of the lesser incidence of

excitement. These drugs should be given by mouth not intravenously (except in eclampsia) and should be given in repeated doses suiting the total dosage to the needs of the patient. The first dose of $1\frac{1}{4}$ to 3 grains (0.09 to 0.20 gram) of pentobarbital sodium may be given when the cervix is dilated about 3 centimeters depending on the frequency of the pains and the degree of the patient's discomfort. A dose of $1\frac{1}{2}$ grains of this drug is repeated every 30 to 60 minutes depending on the complaint of the patient. Although treatment is individualized in each case the average total dose of pentobarbital sodium in a given case is from 6 to $7\frac{1}{4}$ grains (0.40 to 0.48 gram) or more. This may be supplemented by colonic oil-ether in cases of protracted labor or when the pentobarbital sodium does not control the pain. Reasonable relief of pain rather than complete amnesia is desired so that co-operation of the patient will be retained in the second stage. Morphine need be used rarely and then early in labor and in combination with atropine rather than with magnesium sulphate. A nurse or trained attendant should be in constant attendance. A mixture of nitrous oxide and oxygen perhaps supplemented by ethylene or ether will adequately control the pains of the second stage and during any necessary repair. Sacral block may be used in complicated cases, such as heart disease or tuberculosis.

The ideal analgesia or anesthesia should be safe for both mother and child and should not interfere with the efficiency of uterine contractions or the patient's co-operation so as to decrease to any appreciable extent the number of spontaneous deliveries. As yet no method of relief of pain in labor has been discovered which entirely fulfills this requirement.

As practitioners of obstetrics who wish to relieve unnecessary pain during labor should

we not ask ourselves whether complete amnesia or anesthesia is desirable if this state definitely increases the number of operative deliveries? One may point out many obstetricians competent to perform delivery by means of forceps with a minimal amount of risk to mother and child. Yet the cold facts remain that, by and large the increased use of operative means of delivery is followed by increased morbidity and mortality for mother and child.

In this country the demand for relief of pain by the parturient woman is so insistent that the successful practitioner of obstetrics must use, in most labors some means for its relief. Is it not then incumbent on us to acquaint the laity with the evident fact that there is a fairly definite ratio between the degree of relief of pain during labor and the increase of operative deliveries?

ROBERT D. MOSSEY

WATER BALANCE IN SURGICAL PATIENTS¹

SURGEONS in general realize the great importance of maintaining an adequate supply of water to their patients without which normal chemical and physiological processes cannot go on. The healthy individual maintains his water balance by responding to hunger and thirst, but the surgical patient often because of his disease or operation cannot obtain fluids through normal channels. The fluid intake is then governed by the surgeon.

Water becomes available to the body largely by the ingestion of food and drink and is excreted through the kidneys as urine from the gastro-intestinal tract in the stool and from the lungs and skin. This last output is an important part of the heat dissipating mechanism of the body. It is visible when

sweating occurs but generally is an insensible process. For this reason it has seldom been considered in calculations of water requirements although the volume of water involved may be greater than the urinary output.

Studies of patients during operation and in a four hour recovery period show that on an average one liter of fluid is lost during this time, about 70 per cent of which is lost through the skin and lungs. In certain prolonged operations the water thus lost actually amounted to over 2 liters. This loss can be lessened greatly by diminishing the blankets placed in the ether bed. Similar studies over several days time on a series of surgical patients show that the insensible loss of water for the simple, uncomplicated case varies from 1,000 to 1,500 cubic centimeters of water, daily. This volume corresponds approximately to that of a normal individual in the same environment. Studies on surgical patients with infection, fever and hyperthyroidism showed that these factors keep the insensible loss at a level much higher than in the normal person in general closely approximating 2 liters per day. This figure furnishes a sufficiently accurate estimate of the daily insensible water loss of the sick surgical patient. The visible fluid losses from the gastro-intestinal tract by vomiting, diarrhea and from the kidneys are easily ascertainable. The summation of the total of these visible losses and the 2 liter insensible factor gives the total water losses for the period.

Water will be utilized by the body for the dissipation of heat at the expense of water needed for the excretion of waste material through the kidneys. The kidneys do not have the privilege of taking a share of the supply of available water but function with the water left after all other physiological and pathological water needs have been cared for. The volume of urine output is therefore the

¹From the Department of Surgery, University of Michigan.

best indication as to the sufficiency of the water supply. For the sick surgical patient it should be about 1500 cubic centimeters daily. A low urinary output by a seriously ill patient is frequently thought to be due to a suppression of kidney function by toxins. There are many causes of anuria but none of them should be considered until the water exchange of the few previous days has been checked over and dehydration as the etiologic factor eliminated.

The choice of fluid to be given should depend entirely upon the material to be replaced. The chief body fluid electrolytes are sodium and chloride ions. Abnormal losses of fluids from the gastro-intestinal tract always carry away appreciable amounts of these sub-

stances as do also massive inflammatory exudates. Sodium chloride should then be replaced with the water. Many times, however fluids are given simply to prevent dehydration the patient because of the nature of the disease or operation being unable to ingest a sufficient amount of fluids by mouth. A five per cent glucose solution which is nearly isotonic, is preferable in these cases because it supplies the needed water furnishes some food and prevents ketosis.

Parenteral fluids should be administered in quantities calculated to meet the requirements of the individual thus avoiding the dangers of volumes too small or the discomforts of those too large.

FREDERICK A. COLLIER



THOMAS J WATKINS
1863-1925

MASTER SURGEONS OF AMERICA

THOMAS JAMES WATKINS

NINE years have elapsed since the death of Thomas James Watkins. Now that time has partially assuaged the grief and sense of personal loss which his friends experienced at his sudden demise the intrinsic greatness of this man stands out more clearly. As a gynecologist, teacher, and contributor to the advancement of the gynecology of his period he is destined always to have a prominent place in its annals.

He was born on July 6, 1863, near Utica, New York, and died on April 1, 1925. His boyhood days were spent on a farm. In the days of reconstruction following the Civil War, his lot was an unusually severe one. The work was hard and the pleasures and privileges few. From such humble beginnings have sprung many other great Americans who have mastered their destinies. He attended the local schools when circumstances permitted. Later he attended Holland Patent Academy and Adams Collegiate Institute. At some early period there came to him the ambition to study medicine for he entered the University of Michigan at the age of 17, and spent three years there (1880-1883). He graduated, however, from Bellevue Hospital Medical School in 1886. Evidently aspiring to better preparation, he served internships in the Utica (New York) City Hospital, in St. Peter's Hospital in Brooklyn, and in the Woman's Hospital in New York. In the Woman's Hospital he came under the direction of Thomas Addis Emmet, that great pioneer in plastic surgery which constituted so great a part of the gynecological surgery of that period.

Dr. Watkins moved to Chicago in 1889 and soon afterward joined the staff of Northwestern University Medical School. He continued in close association with this school until his death, at which time he was chief of the department of gynecology. He was an exceptional teacher, he not only taught his students sound principles but was able to convey to them a part of his own earnestness and enthusiasm. He spared no time or effort in being helpful to younger men—one of his finest attributes—and exerted a marked influence over the lives of his associates, many of whom owe their success in no small measure to him. He became a Fellow of the American Gynecological Society in 1896 and was its president in 1916—a distinction conferred only on men of exceptional and genuine merit.

From the beginning (1889) Dr Watkins contributed generously to gynecological literature. There was a soundness in his opinion that soon won for him a place among its most dependable authors. He wrote and published, in all, some 116 papers. Taken together they would have made a fairly complete list of the subjects that were interesting to the clinician at the time they appeared. In addition to these we find his name appearing frequently in the discussions at scientific meetings. Whenever he spoke it was always to add something of soundness and good judgment. His published writings reflected his deep interest in clinical gynecology. With a respectful regard for the opinions of others, and for accepted formulas and procedures, he did not hesitate to express a contrary opinion whenever the ideas being advanced did not conform to his own experience. One listened or read with a feeling that his conclusions were those of a keen clinical observer. He helped materially to establish an attitude of conservatism in the treatment of abortion and puerperal infections. His simple treatment of the infected abdominal wound shortened healing and prevented a protracted convalescence. He wrote of extra uterine pregnancy, the management of pelvic infections, gonorrhea in women, fibroids, ovarian tumors, dysmenorrhea, ovulation and menstruation as postoperative considerations, prophylaxis of uterine cancer and innumerable other subjects of interest to the profession. In fact there was nothing in clinical gynecology that did not interest him and few subjects escaped his pen. Perhaps his most valuable contributions were those dealing with gynecological plastic surgery which purposed to transmit to others his own original ideas in this field in which he was considered a genius. Among these were some five or six articles on the transposition operation.

As an operator Dr Watkins was courageous, calm, ingenious, dexterous, and soft of hand and touch. He brought to the operating table a fine sense of mechanics and a clear, judicious mind that meant success where others might have failed. His skill was perhaps best seen in his plastic work. He sensed quickly the problem that was before him in all its details, made his incisions and found his lines of cleavage with unerring accuracy and little loss of blood and placed his sutures perfectly with a fine sense of stress and strain, thus, when all was done the parts were beautifully restored and free from tension. In doing these operations he depended much on the scissors in the use of which he was extremely expert. With every master surgeon there is withal something of the spirit of the pioneer. In his vaginal operations and more particularly in those of the anterior vaginal wall, including the urethra and bladder, he contrived many useful procedures. Contemporaneously with Dieffenbach and Schauta, but independently, he conceived and developed the transposition operation later commonly called the interposition operation and known also in America as the 'Watkins operation'. It was a clever application of mechanical principles. Through an anterior vaginal incision he partially freed the bladder from the vagina and uterus, entered

the abdomen anterior to the uterus, brought the fundus forward and placed and sutured it snugly between the bladder and anterior vaginal wall. It gave permanent relief to those women beyond the menopause suffering from vesico-uterine prolapse. The procedure has found a permanent place in gynecological surgery. Moreover, he devised and developed other operations for uterine prolapse in younger women and under a variety of conditions. Uterine prolapse was formerly one of the most difficult problems to the gynecologist. He did certainly as much as any other man of his day to enable one to attack these cases with confidence and with satisfactory results.

This is an account of a master surgeon and as such is intended to portray his scientific attainments. However no one of us who knew Dr. Watkins will ever be able to think of him from this standpoint alone. His was a remarkable personality which won for him the admiration and the devotion of innumerable friends. He was gentle of manner and sincere. He possessed that sense of honor characteristic of the finest men. In him were marvelously combined force and charm. A certain seriousness of mind was relieved by a rare sense of humor that made him ever a delightful companion. His stories, his smile, his little mannerisms—who can forget them? One does not know which to admire most, the master surgeon or the man.

RICHARD R. SMITH

EARLY AMERICAN HOSPITALS

THE EARLY DAYS OF THE MONTREAL GENERAL HOSPITAL

H. E. MACDERMOT M.D. F.R.C.P. (C.) MONTREAL, CANADA

THE Montreal General Hospital is now in its 113th year of existence, which enables it to claim an antiquity that is respectable (but not any more remarkable than that) among the hospitals of North America. It has, on the other hand a history of clinical teaching which suffers from no such mediocrity as it antedates by very many years that of any other hospital on this continent.

When the institution began its work in 1819 there was only one other hospital in the city—the Hôtel Dieu, with its true record dating back to 1644.¹ But the Hôtel Dieu was small and Montreal at the opening of the 19th century was beginning to be sharply afflicted with its still persistent growing pains. The city was also a natural settling basin for the immigrants who, after the Napoleonic wars, came across the Atlantic in such streams, and immigrants meant poor people, desperately poor in most cases, and often suffering from typhus, or from typhoid fever or cholera.

The first quickening of the hospital may be traced in the work of the Female Benevolent Society of Montreal, which had been formed in 1816 to deal with the destitution in the town. Among the activities of this society was the opening, in 1818, of a small hospital of four beds, appropriately and pleasantly designated the 'House of Recovery'. In 1819 the work of this now indispensable institution was taken over by a committee of business men, who thereupon put their hands to a plough which has been mainly guided by business men ever since. They bought a house in another part of the city—on Craig Street—with room for 24 patients, the bedding being supplied by the military authorities from disused army stores.

It was now called the Montreal General Hospital, and had an attending physician, Dr. Blackwood, a retired army surgeon. The medical work had so far been done by volunteers, whom we find being thanked in the newspaper (the *Montreal Gazette*) by Mrs. Gibb, directress of the Benevo-

lent Society. She begged leave in the name of that institution

to return its sincere thanks to the several gentlemen of the Faculty for the gratuitous advice and assistance which they have cheerfully and promptly afforded. Many distressed objects have been relieved by their timely professional skill who have no other means of expressing their gratitude than by this public acknowledgment.

The gentlemen of the Faculty² were to continue giving gratuitous assistance for a much longer time than any of them suspected and surely they have never been thanked more graciously than in this dignified but thoroughly sincere acknowledgment.

But the hospital had yet to root itself permanently. This it did in 1822 when it settled down on the site on Dorchester Street, which it has occupied ever since. The cornerstone of the new building had been laid with great ceremony on July 1, 1831.³ Three men may be mentioned specially among the founders—the Hon. John Richardson, William McGillivray, and Samuel Gerrard. It was they who bought the land, which was then a nursery garden. Many others, of course contributed to the building, but, in the way buildings have, it cost nearly double the original estimate. The debt was paid off the next year by Mr. Richardson. If the hospital were to be called by any other title it would be hard to find a name it should more appropriately perpetuate than that of John Richardson. The next best thing was the building, as a memorial to him of the east or Richardson wing.⁴

In spite of the present dense surrounding city undergrowth, it may still be realized that the hospital stands on a considerable ridge of land, and that originally the site may well have presented the features of salubrité and open country for which it was selected. In this neighborhood

¹ This is the year of incorporation, and is considered as its first year.

² The hospital has always been dependent on the benevolence of such voluntary 'T' men and women (from them is therefore an aptitude test), but there is an equally weak link between associations with the hospital, that of the Medsons. The hospital charter was applied for by the Hon. Wm. Medson in 1821, and he later became the President. Few of his descendants have since occupied the position, the tradition being carried on (present) (1914) by Colonel Herbert Medson.

³ An institution called the Hôpital Général de Montréal was founded in 1644, but it was a playhouse and school for teachers rather than a hospital. It ceased to function in 1759.



Fig. 1. The hospital in about its fifteenth year viewed from behind. Considerable foreshortening in relation to Mount Royal. (From *Hackmata Depicta* 1830)

there had been in the French régime a fort, the Redoute de l'Enfant Jésus part of the outer defences of the town.

The original hospital plans called for a central building of two stories with basement and attic 76 by 40 feet, and a capacity of 72 patients. As time and circumstance allowed two wings were to be added, each with a further capacity of 72, so that the whole would form a very compact and serviceable establishment. Circumstance was duly obliging the east or Richardson wing being added in 1832 and the west in 1848 as a memorial to Chief Justice Reid by his widow. Other wings and enlargements and annexes have sprouted forth in the course of the century such as were not dreamed of by the original architect, but the original plain, well-proportioned grey stone building

Still stands serene, inviolate,
Though millions have its pavement trod

The original medical staff of the hospital consisted of J. Stephenson, William Robertson, A. F. Holmes, William Caldwell and P. Loedel. With the exception of Loedel, they were all Edinburgh men. Caldwell had been an army surgeon, and had seen service in the Peninsular War. He was a man of resolute character. When the charter of the hospital was applied for in the local legislature in Quebec, it was opposed by a Mr. O'Sullivan in a speech as vehement as it was injudicious. Dr. Caldwell said what he thought of the speech in an indignant and forcible letter to a Montreal paper

(the *Courant*). Perhaps he went a little too far, however in adding a direct personal insult to Mr. O'Sullivan who seems to have been no worse than an ordinarily hot headed if bigoted, Irishman. At any rate, he showed that he had more than mere political spirit in immediately calling the doctor out.

The duel was fought at six o'clock on a Sunday morning near the Windmills a ground close to the St. Lawrence—it had witnessed similar meetings before. As the combatants used pistols carrying ounce bullets and exchanged five shots, we can not misunderstand their intentions towards each other. The shooting was good enough to give Caldwell a shattered arm, and O'Sullivan a bullet through his chest, but both recovered and the charter was granted in due course.

It had been the intention of the medical board from the very first that teaching should be carried on in the hospital. This indeed had been one of the points attacked by Mr. O'Sullivan with all the ardor of the half baked politician's ignorance. In the autumn of 1824 a medical school the Montreal Medical Institute, was opened in connection with the hospital, and 25 students were enrolled. This was the beginning of that long and unbroken tradition of teaching which has already been mentioned and the feature which distinguished it from that done in other hospitals was that instruction was given at the bedside and in the ward. The school eventually became merged into the Faculty of Medicine of McGill University,



Fig. 2. The hospital as originally planned, finished in 1848 by the addition of the Reed wing.

but the use of the hospital for clinical teaching never ceased. Osler tells us¹

When I began clinical work in 1870 the Montreal General Hospital was an old, crooked and rat-ridden building, but with two valuable assets for the student—much acute disease, and a group of keen teachers. Pneumonia, phthisis, sepsis, and dysentery were rife. The "secesses" were not separated, and a man for three months looked after medical and surgical patients, jumbled together in the same wards. The physician of the men who were really surgeons was better than the surgery of the men who were really physicians, which is the best that can be said of a very bad arrangement.

Students have been from the beginning there for an accepted part of the life of the institution, and it has always had by laws governing their admission and behavior. Among the earliest of these is one directing that the student should remove the hat while in the operating theater both that he may not obstruct the view of others, and as a mark of respect.

The medical records of the hospital for the first 30 years or so consisted of quarterly reports. Typhus fever up to the middle of the century kept the beds constantly full. In 1848 sheds were built alongside the hospital to take care of 150 cases. Two matrons succumbed to the disease, and Dr. Caldwell survived his duel only to die of typhus ten years later. Dr. Loedel had preceded him from the same disease.

Cholera was never admitted to this hospital as such, although in 1849 the Board of Health asked that cases of it be taken in during the course of one of Montreal's periodical visitations of the disease. It did appear in the wards, however, from time to time. The first matron died of it. Fevers

formed the bulk of the cases, including the still all-too-familiar typhoid. When a fever could not be diagnosed it was reported as a "synochus," a term we could still occasionally use as it only means an obscure, long-continued fever.

Smallpox was treated at the hospital up to 1876 when the smallpox ward, a separate building annexed to the east wing, was finally closed. Osler was the last to be in charge of this ward, and contracted a mild attack of smallpox himself in spite of repeated (though unsuccessful) vaccinations. He had only 16 pocks, according to his own scrupulous and characteristic record.

We have little to tell us of the methods of treatment. Bleeding was as much in vogue as any where else, and orders for bleeding basins are to be found in the records. Drugs occupied a much larger place than they now do, and alcoholic stimulants were freely given. Whiskey in the first year was ordered by the ten-gallon lot, and the minutes of the Committee of Management have many references to the supplies of liquor. Discrimination was exercised as one entry records the Committee "sampling" brandy and port wine before ordering a hoghead of each. The late Dr. F. J. Shepherd said that even in his day every patient was given some stimulant, two bottles of ale or stout, four to eight ounces of port wine, or four ounces of whiskey or brandy. Once we find a protest at an excessive consumption of spirits, "the last pipe of wine being consumed in little more than three weeks." Dr. Shepherd suggests in his history of the hospital² that much of the wine was drunk by the nurses. It is probable that the con-

¹The medical clinic. Brit. M. J. Jan. 2, 1914.

²Francis J. Shepherd, M.D. *Origin & History of The Montreal General Hospital*.



Fig 3 The hospital in 1881 at the time of Osler's service there. Later the cupola was removed and a mansard roof added. (By courtesy of Dr Maude Abbott)

ditions of nursing were such as to make this not inexcusable there was only one night nurse to look after several flats, and a patient might have to be strapped to his bed while the nurse went to the other wards. In the early reports numbers of patients are shown as being discharged for irregular conduct.

The wards were not lighted even by gas until 1841. Lanterns were used, or wicks floating in tumblers of oil. The governors in one place speak with grave concern (and very rightly so) of the dangerous habits among the patients of 'lighting pipes and segars' at these lamps and of the more serious trick they had of hiding their pipes in their straw beds for fear of detection. There must have been many times when groups of them in their nightcaps could have been found sitting round these flickering lights, smoking their pipes and segars.'

The momentum with which the hospital was so enthusiastically launched, has never been lost. Not that there have been no periods of depression and anxiety in its life. In 1827, for example, it was felt necessary to reduce the establishment to three wards requiring but two nurses, one house and laundry maid, one cook and one manservant. In 1846, too it was recommended to close up as many wards as could be done with propriety to diminish the expenses of the hospital to the lowest limits.' And again, in 1850 it was urged that no more wards be opened than was absolutely necessary to prevent contagion on account of the low state of the funds of the hospital. Occasionally there is recorded the unusual and pleasing

phenomenon of income exceeding expenditure, as in 1872 and for some years after. Alas, that was very long ago!

But the growth of the hospital to its present dimensions is a fair index of its unflinching vigor. Perhaps the more spectacular changes have been on the surgical side, as would be the case with any institution with a pre Listerian existence. Dr F. J. Shepherd was until quite recently (he died in 1929) a link with that period of septic darkness which preceded the Listerian dawn, and his active and retentive mind would recall it vividly. He had seen and been taught by the old surgeons who made a point of using well worn and well infected coats in which to operate, but who on the other hand operated often with a speed and precision not seen nowadays. Lister's methods were introduced by Dr Thos. Roddick, who studied under Lister in 1877 and brought back to Montreal a full equipment of dressings and steam sprays. Dr Shepherd notes that 'after the Listerian methods were introduced the man who looked after the instruments no longer attended the post mortems.'

It was, too, no small revolution of method that took place when Osler was put in charge of the autopsy room in 1875. From then on, postmortem material was made to play the important part that it deserved. Osler drew heavily on his multitudinous records, assembled here, for his textbook and various lectures.

The first X-ray apparatus in the hospital was installed in 1898, this was only 2 years after Roentgen's discovery. But the first X-ray taken in connection with the hospital had been in the

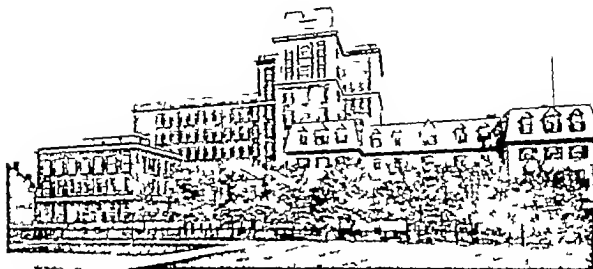


Fig. 4. Showing, from left to right, the Pathological Building, the new wing, and original buildings.

McGill Physics Department in February 1896 by Professor Cox, who at the request of Dr. Kirkpatrick, a member of the hospital staff took a picture of a wounded leg. The occasion is interesting as being the first instance on this side of the Atlantic of the rays being used for clinical purposes. Incidentally it was the first instance on record of their being accepted as medico-legal evidence, as the picture later was produced in court in connection with the case.

Some details of the management of the hospital may be of interest. As shown by the Visiting Book for 1823 it was the governors who first thought of having screens in the wards.

We think it would be an improvement were a few movable screens of some cheap and light material made, so that they could be slipped in between the beds occasionally—such screens seem particularly wanted in the women's ward.

Nothing seems to have been done about it, however, and the next month another governor took it up.

I reiterate the suggestion heretofore made of a further improvement which might materially add much to the relief and convenience of the sick, with little increase of trouble at a trifling expense. As the Patients are now lodged, there are numbers in the same room at all times exposed to the view of each other. To some this may be a matter of indifference, but to others of more delicate mind or habit, and to any in certain states of feeling, to be perpetually exposed to the gaze of others, or to be compelled to see what is passing, may occasion no slight degree of painful sensation, and to these some greater degree of privacy might be a source of comfort and gratification, and so far of salutary influence.

The Committee of Management then replied decisively that

They have consulted with the medical gentlemen in attendance, and they do not approve of the above plan, of supplying the wards with screens, as the free circulation of air would thereby be impeded.

The matter of slippers next engaged the attention of the Governors.

We recommend that (if approved by the medical men) a few pairs of slippers (without quarter) be procured for the use of the Patients.

This was attended to, the Steward was requested to provide "three dozen half made Beef Shoes to serve as slippers in the wards for the patients." There is also a recommendation that a Sedan Chair be procured for the purpose of transporting patients from their respective wards to and from the Baths.

Nightcaps for the patients were part of the patients' wardrobe, as shown in the early lists of hospital stores. One other unusual item among the early purchases is that of "twelve spittoons." These were placed in the wards later on a complaint appears regarding their misuse at night by the patients.

A few words only can be said about that most important aspect of hospital life, the nursing. At first the nurses were classed with the servants, the records giving full details regarding their wages and meals: the latter included

Tea and bread and butter for breakfast and supper meat and soup for dinner with seven gallons of beer per week. The quantity of butter shall not exceed six lbs. per week. The matron shall be allowed two pounds of butter per week.

The wages shall be not more than five dollars a month

Nursing as we think of it was a fairly late development. In Dr Shepherd's words

There were few nurses and no training of nurses. At that time nurses were born not made, mostly of the "Surrey Camp" variety: often good motherly women, but many were addicted to the bottle.

The first matron, Mrs. Stephenson, was appointed with the precautionary proviso *ad vitam aut ad culpam*, but as her salary was only thirty pounds per annum the precaution was probably superfluous. As a matter of fact she proved to be an excellent servant to the institution.

No serious attempt was made to improve the nursing situation till 1875, when four nurses were brought out from Miss Florence Nightingale's school at St. Thomas Hospital, under a Miss Machin, who was a Canadian. For three years they did excellent work in the hospital and would probably have established a training school if circumstances had not brought about their resigna-

tion and return to England. A new era in nursing began with the appointment in 1890 of Miss Norah Livingstone, a graduate of the New York Hospital. Dr. Shepherd, with his usual forcefulness of expression, refers to her task of setting things to rights as 'the cleaning out of the Augean stables.' It may not have been quite as bad as that, but it was bad enough. More than doing this, however she created something new, and that was a training school for nurses which was and is second to none on the continent.

Miss Livingstone was a woman of outstanding personality, and had a long term of service, 30 years. She not only attracted a very fine type of woman to the work, as so often one sees a strong character do, but she made her good material even better. To quote Dr. Shepherd once more

The fame of the school spread abroad and her nurses were sent to all parts of the country. Many became superintendents of nurses elsewhere. Many devoted themselves to public service, others to private work, some died and some got married. The success of the school was chiefly due to Miss Livingstone. She was a woman of infinite tact, had a strong sense of humour, was a good judge of character and a strict disciplinarian. She could not put up with any gross breach of discipline and did not suffer fools gladly.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE six hundred page monograph entitled "The Physiological Effects of Radiant Energy," by Henry Laurens, professor of physiology at the Tulane University School of Medicine is one of a series issued by the American Chemical Society. The editors of this series of monographs state that one of their purposes is to promote research in the branch of science covered by the monograph by furnishing a well digested survey of the progress already made in that field and by pointing out directions in which investigation needs to be extended. This monograph admirably fulfils this purpose.

The medical profession agree upon the possibilities of radiant energy in the treatment of a few diseases, but realized that its mode of action is still unknown except in a few instances and that there is no accepted method of estimating the proper dosage. Therefore the need of further research is evident, and, by giving a review in detail of the more outstanding evidences of the physiological action of radiant energy this volume should stimulate this research.

In view of the positive statements, that cannot be believed, but which are continually being made by the manufacturers of artificial ultraviolet lamps, it is an indication of the value of this book when the author states: "No doubt many readers will be annoyed at the inconclusiveness of some of the statements and arguments. In several of the divisions considerable work is still being done and in others much must still be done in order to clear up the contradictions that have arisen as a result of differences in manner of attack, and inattention to quantitative matters which would have rendered repetition possible. The author has avoided drawing conclusions in most instances, so that this work is a most valuable source book on the work that has been done in the physiological effects of radiant energy. The bibliography is extensive and complete. It is therefore an outstanding reference work on its subject, and will be invaluable to any one interested in the action of radiant energy." JOHN S. COZZILLA

SURGICAL lesions of stomach and duodenum are discussed in J. Shelton Horsley a new book.² In the opening chapter embryology anatomy and physiology are covered. There is a good summary of laboratory anatomy which, however, lacks correlation with surgical procedures and relationships. The

reviewer regards this section as seriously lacking because little more is presented than what we find in a general text on surgery.

The chapters covering diagnosis of gastric and duodenal ulcer and carcinoma are well done, with the exception that there is practically no discussion of the surgical pathology of ulcer. The occasional difficulty of finding or identifying small ulcers, and methods of exploration preliminary to decision as to operation are facts the student of gastric surgery needs, at times sorely.

There is a chapter on preliminary preparations, incisions and postoperative treatment following, one on operations for pyloric stenosis, cardiospasm, etc. The remaining chapters are devoted finally to the technique of various gastric and duodenal operations, including pyloroplasty gastro-enterostomy, various types of resection, excision, treatment of fistula and cholecystoduodenostomy.

The author leans to the conservative side in the treatment of duodenal ulcer—being opposed to resection for this lesion. In this stand he has many supporters, but he is inviting discussion in stating that of the two conservative measures for duodenal ulcer pyloroplasty is preferable to gastro-enterostomy because in the event of failure re-operation is easier. Far more space and emphasis are given to the Billroth I resection than the Pólya, a procedure generally recognized as having a wider field of application and greater margin of safety.

The author's teaching of the fundamentals of gastric surgery is essentially sound but lack of illustrated detail would make it difficult for the young or inexperienced surgeon to grasp details of operative technique. J. R. BROTHMAN

THE three Gehrman lectures delivered by Dr. F. Pusey at the University of Illinois in 1933 have been assembled in a single volume.³ The titles of the three lectures are "The Beginning of Syphilis," "The Development of Our Knowledge of Syphilis," and "The Epidemiology of Syphilis."

In the first lecture the author shows with very definite evidence that syphilis originated in the West Indies and was transmitted to Europe by the sailors of Columbus first expedition. At the end of the fifteenth century an army organized by Charles VIII of France invaded Italy. Many of the soldiers were already infected with the disease, and from them it quickly spread over Italy and then to the rest of

THE PHYSIOLOGICAL EFFECTS OF RADIANT ENERGY. By Henry Laurens, Ph.D. American Chemical Society Monograph Series. New York: The Chemical Catalog Company, Inc. 1933.

RESECTION OF THE STOMACH AND DUODENUM. By J. Shelton Horsley. M.D. FACS. LL.D. St. Louis: The C.V. Mosby Company. 27 pp. 1933.

THE HISTORY AND EPIDEMIOLOGY OF SYPHILIS. The Gehrman Lectures. University of Illinois. By F. Pusey, A.M., M.D., LL.D. Springfield, Illinois, and Baltimore: Maryland: Charles C. Thomas, 1933.

continental Europe. In this chapter the author shows that through the studies of Ivan Bloch Haustein and other investigators syphilis has been definitely proved to have had its inception in Europe with the return of Columbus' crew from the West Indies.

The second chapter is the clinical history of the development of our knowledge of syphilis from the time of Fracastor and Paracelsus to the present day. The first part of this chapter deals with the splendid work done by the earliest observers—splendid when one realizes the limitations of their basic knowledge and scientific appliances. The last half of the chapter is the dramatic story of our more recent developments.

The development of this knowledge is as Dr. Pusey says, a brilliant illustration of what medicine has been able to do in the short period, as history goes, of the last four hundred years, since men have put their minds intensively on the objective study of diseases and their rational explanation.

The last chapter on the Epidemiology of Syphilis is an interesting consideration of four factors: (1) the reservoir of infection, (2) the infecting organism, (3) the susceptible host and (4) the means of transmission.

Dr. Pusey believes that 5 per cent is a fair estimate of the incidence of syphilis for the entire population. European statistics indicate that it is more frequent in European cities than American. Many statistics show it is to be more prevalent in urban than in rural districts. Quoting Dr. Farrar, he says that the annual crop of new cases in the United States is 871,000. The author, however, believes that the disease is decreasing. The remainder of this chapter discusses the methods of transmission, the infecting organism and the sanitary measures promulgated for the control of the infection.

This book is well worth reading, it is well written, printed on good paper and well illustrated. It is an interesting story well told.

THE biological principles underlying the clinical radiological and histological diagnosis and per-versions of growth and disease in the skeleton are presented in an unusually clear, sound, and readable manner by Harris in his book *Bone Growth in Health and Disease*. The origin of the dense transverse lines of the diaphysis is described in detail. These lines are correlated with the onset and duration of nutritional and disease states both antenatal and postnatal. Excellent cuts showing pathological sections illustrative of the lines of arrested growth are numerous.

Part II is given to a consideration of bone growth in reference to deficiency diseases. The origin and growth of cartilage is carried through the stages of senescence degeneration and calcification of car-

tilage cells. The author considers the origin of the osteoblast from many angles and suggests that they originate from rejuvenated cartilage cells at the zone of epiphyseal growth. Growth disturbances occurring in rickets and scurvy are shown in extensive radiological and pathological studies supported by animal experimentation. Mitotic figures in epiphyseal cartilage are shown in specimens from small embryos and the growth of cartilage toward the epiphyseal line and toward the articular surfaces is illustrated. Perversions of cartilage growth in achondroplasia and fetal abnormalities are described in the author's clear manner.

The specific changes of bone growth in syphilis and tuberculosis are described. Chapters on growth and disease of the spine, age changes in the skull and costal cartilages are concise and informative.

As an authoritative and practical work dealing with the processes and defects of bone growth, this book has few rivals and is highly recommended to those interested in problems of bone growth in both health and disease.

FREDMONT A. CHAMBLER.

THE monograph on *Nasal Accessory Sinuses*¹ is both a manual for the roentgenologist and a text book for the practicing clinician. In the five chapters and two hundred illustrations he has succeeded in giving us a clear conception not only of roentgenographic technique but clinical interpretation as well. Closer association between the rhinologist and roentgenologist is the keynote of the text and the author points out many helpful points in this respect. He has added a great deal toward the anatomical study of the sinuses pointing out minute important points in the interpretation of films which should be of aid to the rhinologist. The plates are especially good and include both normal and pathological conditions. In general the book should be of value to both the rhinologist and the roentgenologist.

JOHN F. DELPHE.

THE material for Schiller's study on granulosa cell tumors² was supplied by the Vienna gynecological university clinic. The older idea that these granulosa cell tumors arise from the mature follicular epithelium of the ovary is rejected in favor of the hypothesis that embryonic rests of the mesenchymal anlage of the ovary may undergo neoplastic changes. Thus a scale of different tumors may be produced from primitive sarcoma like structures to the highly differentiated forms which imitate the adult, epithelial granulosa cell of normal follicles.

The clinical characteristics of these tumors are discussed and the attempt is made to divide the whole group into sixteen benign and eight malignant tumors. The significance of a differential diagnosis from the carcinoma of the corpus uteri in postclimacteric hemorrhages is emphasized and other cases

¹ *BONE GROWTH IN HEALTH AND DISEASE, THE BIOLOGICAL PRINCIPLES UNDERLYING THE CLINICAL, RADIOLOGICAL, AND HISTOLOGICAL DIAGNOSIS OF PERVERSIONS OF GROWTH AND DISEASE IN THE SKELETON*. By H. A. HARRIS, M.Sc. (London), M.B., B.S. (London), D.Sc. (Wales). M.R.C.S. M.C. & C.P. London: Oxford University Press, 1935.

² *ATLAS OF ROENTGENOLOGY: A SERIES OF MONOGRAPHIC CASES, Edited by JAMES T. CASE, M.D., Vol. XVI—NASAL ACCESSORY SINUSES*. By FREDERICK M. LAW, M.D. New York: Paul B. Hoeber Inc., 1935.

³ *PATHOLOGY AND CLINICAL GRANULOSA CELL TUMORS*. By Dr. Walter Schiller. Vienna: Wilhelm Maudrich, 1934.

are cited with phenomena which are produced by an abnormal hormone formation within the tumors, amenorrhea, and masculinization. Attempts failed to produce similar tumors artificially in mice by injections of mixtures of pregnancy urine and coal-tar solutions. Only in one mouse one tumor was found which resembled histologically a human, undifferentiated granulosa cell tumor.

This thorough histological and clinical study will be of interest mainly to the gynecologist. He may be induced by it to be less persistent in the general application of X ray sterilization following removal of a unilateral granulosa cell tumor in young women—provided that he accepts the author's histological differentiation of the benign and malignant forms.

ARTHUR WEIL.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

HORMONES & SURGICAL MICROGRAPHS. ACUTE INTESTINAL OBSTRUCTION. By Monroe A. McIver, M.D. New York: Paul B. Hoeber, Inc. 1934.

THE HOSPITAL MANUAL OF OPERATIONS. By Walter P. Merrill, Ph.D. M.D. New York: Lakeside Publishing Company, 1934.

SPINAL ANESTHESIA, TECHNIC AND CLINICAL APPLICATION. By George Rudolph Vehr, M.D. St. Louis: The C. V. Mosby Company, 1934.

ZUR BEHEBUNG DER STATISTISCHEN MITTELLEN FÜHRERS (STANDARD ERROR), FORMELN UND TABELLEN WELCHE DER BESTIMMUNG DES IN DER WARENRECHNUNG-KORREKTUR ANGEWANDTEN MITTELLEN FÜHRERS BEZÜGLICHEN. By Dr. med. A. M. Rital. Helsingfors, Finland, 1934.

MODERN DRUG ENCYCLOPEDIA AND THERAPEUTIC GUIDE. By Jacob Gutman, M.D. Phil.D. F.A.C.P. New York: Paul B. Hoeber, Inc. 1934.

GUIDE PRATIQUE D'ANESTHÉSIE ET D'ANALGÉSIE AU PROTOXYDE D'AZOTE OXYGÈNE. By M. Fleury-Lawton. Paris: G. Doin & Co., 1934.

CHRONIC NASAL SINUSITIS AND ITS RELATION TO GENERAL MEDICINE (CHRONIC SINUSITIS AND SYSTEMIC SYPHILIS). By Patrick Watson Williams. With a foreword by Sir Humphry Davy Robinson, Bart., Q.C. & Co., K.C.B. 2d ed. Baltimore: William Wood and Company, 1935.

ANNUAL REPORT OF THE REPORTS OF THE COUNCIL OF PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION FOR 1933 WITH THE COMMENTS THAT HAVE APPEARED IN THE JOURNAL. Chicago: American Medical Association, 1933.

NEW AND NONOFFICIAL REMEDIES, 1934, CONTAINING DESCRIPTIONS OF THE ARTICLES WHICH STAND ACCEPTED BY THE COUNCIL OF PHARMACY AND CHEMISTRY OF THE AMERICAN MEDICAL ASSOCIATION ON JANUARY 1, 1934. Chicago: American Medical Association, 1934.

RECENT ADVANCES IN SEX AND REPRODUCTIVE PHYSIOLOGY. By J. M. Robson, M.D. B.Sc. (Leeds) F.R.S.E. With Introduction by Professor F. A. E. Crew, M.D. D.Sc., F.R.S.E. Philadelphia: P. Blakiston's Son & Co., Inc. 1934.

DISEASES PECULIAR TO CIVILIZED MAN. CLINICAL MANAGEMENT AND SURGICAL TREATMENT. By George Crile, M.D. New York: The Macmillan Company, 1934.

GYNÆSTETIC MEDICINE. THE DIAGNOSIS AND MANAGEMENT OF THE COMMONER DISEASES IN RELATION TO PREGNANCY. Edited by Fred L. Adair, M.A., M.D. F.A.C.S. and Edward J. Stangor, M.S. M.D., F.A.C.P. Philadelphia: Lea & Febiger, 1934.

ECOLOGIA Y PATOLOGIA DE LA MUJER. TRATADO DE GYNÆSTETICA Y GYNÆCOLOGIA. By Josef Halban and Ludwig Seta. Tome IV. Madrid: Editorial Plus Ultra, 1934.

RADIOLOGIC EXPLORATION OF THE UTERUS OF THE GASTRO-INTESTINAL TRACT. By The Cole Collaborators. Saint Paul and Minneapolis: The Bruce Publishing Company, 1934.

LEBENS UND KLINIK. Prof. Dr. Jule Izbarn. Contributions by his associates and pupils in the Department of Clinical Gynecology. Buenos Aires, 1934.

THE PRINCIPLES OF GYNAECOLOGY. A TEXT BOOK FOR STUDENTS AND PRACTITIONERS. By William Blair Bell, B.S. M.D. (Lond.), F.R.C.S. (Eng.) F.C.O.G. Hon. F.A.C.S. Hon. LL.D. (Glasg.) 4th ed. Rev. with the assistance of M. M. Dainow, B.Ch. (Liverpool) F.R.C.S. (Edin.) M.C.O.G. and Arthur C. H. Bell, M.B., B.S. (Lond.) F.R.C.S. (Eng.) M.C.O.G. Baltimore: William Wood and Co. 1934.

THE CHEMISTRY OF THE HORMONES. By Benjamin Harrow, Ph.D., and Carl P. Sherrin, D.Sc., M.D., Dr. P.H. Baltimore: The Williams & Williams Company, 1934.

THE CYCLOPEDIA OF MEDICINE. George Morris Merrill, B.S. M.D. Editor-in-Chief and Edward L. Bortz, A.B. M.D. Assistant Editor. Volumes viii and ix. Philadelphia: F. A. Davis Company, 1934.

MODERN CLINICAL SYPHILOLOGY. DIAGNOSIS—TREATMENT—CASE STUDIES. By John H. Stokes, M.D. 2d ed. Philadelphia and London: W. B. Saunders Company, 1934.

AMERICAN COLLEGE OF SURGEONS

REPORT OF THE MEDICAL SERVICE BOARD

ON July 15 1933, on authorization of the Executive Committee of the Board of Regents of the American College of Surgeons, Dr J Bentley Squier president, appointed a Medical Service Board to study the provision of more adequate medical service to the whole community. The Medical Service Board consists of Robert B Greenough Boston chairman Bowman C Crowell, Chicago secretary G Harvey Agnew, Toronto Charles A. Dukes Oakland Franklin H Martin Chicago C Jeff Miller New Orleans Eugene H Pool New York Arthur M Shipley, Baltimore J Bentley Squier New York S Marx White, Minneapolis.

On June 10 1934, the Medical Service Board made a report to the Board of Regents of the College which was approved by that Board. The report is a statement of principles which should be observed in the development and conduct of prepayment plans for medical and hospital service and does not propose any specific plan.

The Medical Service Board of the American College of Surgeons respectfully submits the following report to the Board of Regents.

1 The American College of Surgeons affirms its interest and its desire to co-operate with other agencies looking toward the provision of more adequate medical service to the whole community.

2 The College believes that it is the duty of the medical profession to assume leadership in this movement and to take control of all measures directed to this end.

3. Encouragement should be given to the trial of new methods of practice designed to meet these needs, and a careful evaluation of their success should be the duty of the medical profession before they are offered for general adoption. All such new and experimental methods of practice must be conducted strictly in accordance with the accepted code of ethics of the medical profession in order that the interests of the patient and the community may be protected.

4. The College recognizes for immediate study four groups of the population for whom more

adequate medical service should be made available as follows

(a) The indigent

(b) The uneducated and credulous members of the community

(c) Those who because of limited resources are unable unaided to meet the costs of serious illness and hospitalization.

(d) Those living in remote districts where adequate medical service is not obtainable

5 The care of the indigent sick should be a direct obligation upon the community and (unless otherwise compensated by intangible benefits such as staff and teaching appointments, opportunity and experience), physicians fulfilling this public service should receive remuneration.

6 The College should work in co-operation with other medical groups in order to dispel the ignorance and credulity of the public, and to bring the people to a proper realization of the protective and curative resources of modern medicine.

7 The American College of Surgeons recognizes that the periodic prepayment plan providing for the costs of medical care of illness and injury of individuals and of families of moderate means offers a reasonable expectation of providing them with more effective methods of securing adequate medical service.

A number of different plans for the organization of such services have been proposed although few have been in operation long enough to permit definite conclusions in regard to their success. It is to be desired that these experiments be continued. Conditions differ to such a degree in different parts of the country that a specific plan which is practicable in one place may require modification of details in other communities. The varying restrictions imposed by present insurance laws in different states further complicate the problem.

Periodic prepayment plans providing for the costs of medical service may be divided into two classes (A) Payment for medical service (B) payment for hospitalization.

It is suggested that plans for the payment of hospitalization alone (Class B) without provision for payment for medical service, may be con-

sidered the first project to be undertaken in the average community.

The American College of Surgeons believes that certain general principles can and should be established the observance of which will tend to obviate known difficulties and dangers which may threaten the success of these special forms of medical service. These principles are as follows:

(a) Periodic prepayment plans for medical service should be free from the intervention of commercial intermediary organizations operating for profit. After deduction of the clerical costs of operation of the fund and such accumulation of reserve as may be advisable in the interest of the contributors or may be legally imposed the full amount paid by the contributors should be available for medical and hospital services.

(b) In the interest of the patient the organization of plans for the periodic payment of medical and hospital costs must be under the control of the medical profession. The medical profession must act in concert with the hospitals and such other allied services as may be involved in the individual project, together with a group of citizens representative of the whole community and of industry who are interested in the successful operation of the plan.

(c) The principle of free choice of the physician and hospital by the patient must be assured to the end that the responsibility of the individual physician to the individual patient shall always be maintained. When hospitalization is required this choice must of necessity be limited to the physicians and surgeons who hold appointments on the staffs of the hospitals participating in the plan or to those physicians and surgeons who are acceptable to the hospital. It is further recommended that only approved hospitals be admitted to participation in such a plan.

(d) The compensation of the physician and of the hospital should be estimated with due regard to the resources available in the periodic payment fund and should be based upon the specific services rendered.

(e) The organization and operation of any plan of this type must be free from any features not in accordance with the code of ethics of the medical profession which code has been established for the protection of the patient.

(f) The medical organizations participating in such a plan must assume the responsibility for the quality of service rendered.

8. Periodic prepayment plans for medical and hospital service should eliminate many of the conditions which have brought about the development of industrial contract practice. Until

such plans have been more widely established certain general principles are here formulated with a view to the elimination of the commercial features of such forms of medical service.

(a) The Minimum Standard for Industrial Medicine and Traumatic Surgery of the American College of Surgeons should be accepted.

MINIMUM STANDARD FOR INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

1. That the industry shall have an organized medical department, or service, with competent medical staff, including consultants, and adequate emergency dispensary and hospital facilities and personnel to assure efficient care of the ill and injured.

2. That membership on the medical staff shall be restricted to physicians and surgeons who are (a) graduates of scientific medicine holding the degree of Doctor of Medicine, in good standing and licensed to practice in their respective states or provinces; (b) competent in the field of industrial medicine and traumatic surgery; (c) worthy in character and in matters of professional ethics, that in the latter connection, the practice of the division of fees under any guise whatsoever be prohibited.

3. That there shall be a system of accurate and complete records filed in an accessible manner—a complete record being one which includes identification data, cause of illness or injury, nature and extent of illness or injury, detailed description of physical findings, special examinations such as coagulability, chemical laboratory and X-ray tentative or provisional diagnosis, treatment, prognosis with estimated period of disability, progress of illness or injury, final diagnosis, condition on discharge, convalescence, and such additional information as may be required by statute for Workmen's Compensation claims or for other purposes.

4. That all patients requiring hospitalization shall be sent to institutions approved by the American College of Surgeons.

5. That the medical department shall have general supervision over the sanitation of the plant and the health of all employees.

(b) Physicians and surgeons, qualified as in paragraph 2 of the above Minimum Standard may properly be employed on a full time or a part time basis by industrial organizations to provide medical and surgical service for their employees, as follows:

1. To provide emergency service and first aid in injury or disease, and to provide adequate medical or surgical care for industrial injuries and diseases. Medical and surgical care of the families of employees, and of employees themselves, except for emergency and industrial injuries and diseases, should be provided by the industrial physician only in remote districts.

where adequate medical service is not available.

ii To provide pre-employment and periodic physical examinations.

iii. To study the hazards of the particular industry and to co-operate with other agencies in effecting such measures as may be needed for the prevention of injury and disease

iv To keep accurate records such as may be required by local Workmen's Compensation laws, and so complete as to serve for scientific investigation of industrial hazards with a view to their further prevention. These records are privileged communications, subject always to due process of law

(c) The sale of a contract by an industrial organization to an individual physician or group of physicians for medical and/or hospital service for its employees encourages commercial competition and is to be condemned.

(d) Unethical practices in publicity, advertising, solicitation, and competition, either of a professional or of a financial nature must be eliminated.

(e) The accepted code of ethics of the medical profession, which is designed to protect the best interests of the patient, should apply to industrial medical service as to all other forms of medical practice

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

WILLIAM D. HAGGARD Nashville, *President*

ROBERT B. GREENOUGH Boston, *President Elect*

FRANKLIN H. MARTIN Chicago, *Director-General*

ARTHUR W. ALLEN *Chairman* ERNEST M. DALAND *Secretary* *Committee on Arrangements*

PRELIMINARY PROGRAM FOR THE CLINICAL CONGRESS IN BOSTON

THE surgeons of Boston have organized under the leadership of a representative committee and are planning to provide for the Fellows of the College and their guests a broadly interesting program of operative clinics and demonstrations at the twenty-fourth annual Clinical Congress of the American College of Surgeons to be held in that city October 25-29. The Committee on Arrangements has been assured of the hearty co-operation of the clinicians at the three medical schools and more than thirty hospitals that will participate in the clinical program, and expects to provide a most complete showing of their clinical activities in all departments of surgery.

A preliminary program of operative clinics and demonstrations as prepared by the Committee on Arrangements, is presented in the following pages. It will be noted that clinics at the hospitals are scheduled for the afternoon of Monday October 25, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days. The program as published is in tentative form and is to be revised and amplified during the months preceding the Congress. The final program will be published from day to day during the Congress—a complete and accurately detailed program being posted in the form of bulletins at headquarters each afternoon for the succeeding day and issued in printed form the following morning. The Committee plans to include in the clinical program many special features, among them being (1) Fracture clinics at which modern methods in the treatment of fractures will be demonstrated (2) cancer clinics demonstrating the treatment of cancer by surgery, radium and X-ray (3) clinics in traumatic surgery for the presentation of methods of rehabilitation of injured patients by surgery and physiotherapy.

A symposium on cancer, under the auspices of the College Committee on the Treatment of Malignant Diseases, will be presented on Wednesday afternoon in the ballroom of the Copley Plaza Hotel. This will include further reports by clinicians from various parts of the country presenting additional statistics on the cure of cancer. Following these reports a series of papers on the treatment of cancer descriptive of methods of treatment will be presented including "Surgical Treatment of Cancer of the Stomach" by J. Shelton Horsley, M.D. Richmond, Va. "Cancer of the Cervix Treated by Surgery and Irradiation" by George Gray Ward, M.D. New York. "Cancer of the Breast Treated by Surgery and Irradiation" by Stuart W. Harrington, M.D., Rochester, Minn. "Cancer of the Lip Treated by Surgery and Irradiation" by Ellis Fischel, M.D. St. Louis.

A conference on fractures, under the auspices of the College Committee on the Treatment of Fractures, will be held in the ballroom of the Copley Plaza Hotel on Tuesday afternoon, and a conference under the auspices of the Board on Industrial Medicine and Traumatic Surgery in the same room on Friday afternoon.

Surgical motion picture films, both sound and silent, will be exhibited daily in the Georgian Room at the Statler Hotel. Many new films will be shown. The showing of films demonstrating clinical features of interest has met with popular acceptance in recent years and will be continued at this session with an enlarged program.

Ether Day will be celebrated at the Massachusetts General Hospital on Tuesday with special exercises at 4 p.m. in the dome room of the old building of the hospital where ether was first administered for the production of surgical anesthesia on October 26, 1846.

EVENING MEETINGS

The Central Executive Committee has prepared programs for a series of five evening sessions a tentative outline of which will be found in the following pages. At the presidential meeting on Monday evening to be held in Symphony Hall, the president-elect, Dr Robert B Greenough, of Boston, will deliver his inaugural address. On that occasion a number of distinguished surgeons from abroad who will be in attendance at the Clinical Congress will be introduced. Among the visiting surgeons will be the following: Prof John Fraser, Edinburgh, Scotland; Dr Bethel Solomons, Dublin, Ireland; Sir Harold Gillies and Mr A. Lawrence Abel, London, England; Mr Harry Platt and Dr William F Shaw, Manchester, England; Dr Alexander MacLennan, Glasgow, Scotland; Dr Rafael Silva, Mexico City, Mexico; Prof Josef Halban, Vienna, Austria. A feature of this session will be the John B. Murphy oration in surgery by Dr Donald C Balfour.

Sessions on Tuesday, Wednesday, and Thursday evenings will be held in the ballroom of the Copley Plaza Hotel at which eminent surgeons of the United States and Canada, together with visiting surgeons from foreign countries, will present papers on surgical subjects of timely importance.

The annual Convocation of the College will be held on Friday evening in Symphony Hall at which the 1934 class of candidates will be received into Fellowship in the College.

OPHTHALMOLOGY AND OTOLARYNGOLOGY

The committee in charge of the section on surgery of the eye, ear, nose and throat has arranged a program of ophthalmological and otolaryngological clinics and demonstrations at the hospitals and medical schools. This will be found in the following pages, and in addition programs for a series of four sessions on Tuesday, Wednesday, Thursday and Friday afternoons in John Hancock Hall, located on St. James Avenue midway between the Statler and Copley Plaza Hotels. At these sessions distinguished specialists will present papers on subjects of timely interest.

A symposium on Diseases of the Esophagus will be presented on Thursday afternoon at 3.30 in the ballroom of the Copley Plaza Hotel following the annual meeting. The program follows:

- An X-ray Study on Lesions of the Esophagus (Statistical study with lantern slides). A. S. MACMILLAN.
Infection of the Esophagus in Acute and Chronic Disease.
Fibrosis of the Terminal Portion of the Esophagus (Cardiospasm). Etiology and Treatment. HARRIS P MOSER.
The Surgical Approach to the Esophagus. EDWARD D CHURCHILL.

ANNUAL HOSPITAL CONFERENCE

An interesting program of papers, round table conferences and practical demonstrations dealing with problems related to hospital efficiency is being prepared for the annual hospital conference, which opens with a session in the ballroom of the Copley Plaza Hotel at 10 o'clock on Monday morning. The conference continues during the following three days with morning sessions at the Copley Plaza Hotel and afternoon sessions, devoted to practical demonstrations, at several of the local hospitals.

It is planned to make this year's program of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives. Particular emphasis will be directed toward professional standards and the vital problems related to medical and surgical economics.

A greatly increased interest on the part of surgeons in both the administrative and scientific phases of hospital work has been evidenced in recent years and the program for this year's conference will be unique in providing for discussion of subjects of greatest interest to the three major hospital groups—medical, surgical and administrative.

HEADQUARTERS

The Statler and Copley Plaza Hotels will be utilized as headquarters for the Congress. At the former the grand ballroom and adjoining assembly room together with other large rooms on the mezzanine floor have been reserved for the exclusive use of the Congress for registration and clinic ticket bureaus, bulletin boards, technical exhibition and executive offices. A scientific exhibit, which will be arranged by the local committee is to be installed in the balcony of the ballroom. At the Copley Plaza Hotel the grand ballroom will be utilized for evening scientific meetings, hospital conferences and other large gatherings daily.

The Technical Exhibition will be located in the ballroom and adjoining assembly room at the Statler Hotel. The registration and clinic ticket desk, together with the information bureau will be located in these rooms in which will also be found the bulletin boards on which the daily clinical programs will be posted each afternoon. The leading manufacturers of surgical instruments, X-ray apparatus, operating room lights, hospital apparatus and supplies of all kinds, ligatures, dressings, pharmaceuticals and publishers of medical books will be represented in this Exhibition.

RAILWAY RATES

We are assured that the railways of the United States and Canada will grant low rates for the Clinical Congress in Boston—approximately one and one-third fares for the round trip on the certificate plan. Applications for reduced fares are now pending before the various railway traffic associations. Persons from the west traveling through Chicago will find it to their advantage to buy round-trip tickets to Chicago at the special low rates in effect because of the Century of Progress Exposition in Chicago. It will then be necessary to purchase tickets to Boston in Chicago taking advantage of the certificate plan.

ADVANCE REGISTRATION

The hospitals and medical schools of Boston afford accommodations for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore that those surgeons who wish to attend the Clinical Congress in Boston will register in advance.

Admittance to all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the

registration fee is issued which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

BOSTON HOTELS AND RATES

Boston hotels will provide ample facilities and there should be no difficulty in securing first-class accommodations. It is advisable, however for those who expect to attend the Clinical Congress to reserve their accommodations as far in advance as possible. In addition to the headquarters hotels, the Statler and Copley Plaza, there are a number of first-class hotels within walking distance of headquarters. The following list of hotels with their rates has been prepared by the local committee.

	Minimum rates with bath	
	Single	Double
Bellevue, 21 Beacon Street	\$3.00	\$5.00
Bradford, 275 Tremont Street	2.50	3.50
Braintree, 404 Commonwealth Avenue	3.00	4.00
Brockway, 320 Boylston Street	2.50	4.00
Buckminster, 645 Beacon Street	2.00	3.50
Canterbury, 14 Charlestown West	2.50	3.00
Charlestown, 335 Beacon Street		4.00
Copley Plaza, 138 St. James Avenue	4.00	6.00
Fenway, 534 Beacon Street	2.50	3.50
Graylyn, 20 Charlestown West		5.00
Hemmenway, 9 Westland Avenue	2.50	3.50
Kennmore, 400 Commonwealth Avenue	3.00	4.50
Lenox, Eweret Street	2.50	3.50
Lincolshire, 20 Charles Street	3.00	4.50
Manger, North Station	2.50	3.50
Parker House, 60 School Street	3.00	4.50
Pontian, 370 Commonwealth Avenue	3.50	5.00
Rita-Carlton, 15 Arlington Street	4.00	7.00
Sheraton, 91 Bay State Road	3.00	4.00
Somerset, 400 Commonwealth Avenue	3.00	3.50
Statler Park Square	3.50	5.00
Touraine, 62 Boylston Street	3.00	5.00
Vendome, 160 Commonwealth Avenue	2.50	4.00
Victoria, 275 Dartmouth Street	3.00	5.00
Westminster, 124 St. James Avenue	2.50	3.50

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 LYMAN RICHARDS, Secretary
 Otolaryngology—THEODORE L. TERRY, Secretary
 Ophthalmology

SCIENTIFIC EXHIBITS

AT HEADQUARTERS, STATLER HOTEL

FRACTURES Demonstrating methods of treating fractures, under the auspices of the New England Fracture Committee of the American College of Surgeons
PLASTIC SURGERY An exhibit of models, photographs and diagrams, illustrating the different methods employed in plastic surgery and the results
TRAUMATIC SURGERY Diagrams, photographs and charts
ORTHOPEDIC SURGERY An exhibit of splints and other forms of orthopedic apparatus, together with charts and photographs
MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH An exhibit illustrating the activities of this department
CANCER An exhibit from the Palmer Memorial Hospital, Collis P. Huntington Memorial Hospital and the Pondville State Cancer Hospital. Lantern slides, charts and photographs illustrating cancer of various organs of the body; the diagnosis and the results obtained by different forms of treatment. Also, an exhibit of specimens of cancer from many parts of the body
OPHTHALMOLOGY Charts and photographs illustrating melanotic sarcoma and other conditions of the eye
PATHOLOGY The specimens removed at operations from the various hospitals in the morning will be collected and placed on exhibition in artificially cooled show cases in the afternoon in a room adjoining the Georgian Room.

At 5 p.m. these specimens will be demonstrated in the Georgian Room by a projectoscope, the microscopic sections shown and the cases discussed.

AT HOSPITALS AND MEDICAL INSTITUTIONS

HARVARD DENTAL SCHOOL An exhibit of models, photographs and diagrams showing the restoration of extensive defects and deformities of the face and jaws by plastic surgery and dental prosthesis, including cases of soldiers wounded in the world war.
BOSTON MEDICAL LIBRARY Exhibit of historical books on surgery and anatomy and surgical medals. Historical program illustrating the development of surgery Wednesday October 27 John Ware Hall, 4 p.m. presented by the students of Tufts College Medical School under the direction of Professor B. Spector. Exhibition of works of art by Massachusetts physicians under auspices of the Physicians Art Society
MASSACHUSETTS GENERAL HOSPITAL An exhibit in the Ether Dome relative to the first public demonstration of ether anesthesia. Showing of moving picture "The First Public Demonstration of Ether Anesthesia"
MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY Anatomical specimens and otological instruments
HARVARD MEDICAL SCHOOL, WARREN MUSEUM Anatomy anatomical specimens pathology pathological specimens

OPHTHALMOLOGY AND OTOLARYNGOLOGY—SCIENTIFIC SESSIONS

Tuesday—John Hancock Hall 2—Ophthalmology

- JOHN M. WHEELER**, New York. Plastic ophthalmic surgery
- JONAS S. FRIEDENWALD**, Baltimore. Slit lamp ophthalmoscopy
- CLARENCE KING**, Cincinnati. Tuberculin in the treatment of ocular tuberculosis

Wednesday—John Hancock Hall, 2—Otolaryngology

- THOMAS I. CANNODY**, Denver. Congenital deformities of the face and neck. Discussion opened by V. H. KAZANJIAN
- LOUIS H. CLIFF**, Philadelphia. Peroral endoscopy in otolaryngological practice
- SAMUEL J. CROWY**, Baltimore. Meniere's symptom complex. Discussion opened by PHILIP M. LEVINE
- JOHN R. PAUL**, New York. Acute infections of the middle ear and mastoid
- O. JASON DIXON**, Kansas City. A departure in the management of acute mastoid disease or the advantages of conservative treatment in acute mastoid disease. Discussion opened by LYMAN K. KNUDSON
- GEORGE M. COATES**, Philadelphia. Diagnosis of chronic infection of the tonsils in relation to indications for operation in cases of chronic focal infection
- WILLIAM V. MULLIN**, Cleveland. Present status of infection of the upper respiratory tract in its relation to focal infection. Discussion opened by H. ARTHUR BALDWIN
- EDWARD ZEIGLERMAN**, San Francisco. The clinical and surgical significance of the component ossicles of the ossicular chain of the temporal bone, based upon a series of 100 ossicles and autopsy observations, lantern slide demonstration

Thursday—John Hancock Hall 2—Ophthalmology

- LUTHER C. PETER**, Philadelphia. How to treat disturbances of binocular vision by exercises: the use of the stereoscope in the treatment of heterophoria and heterotropia
- CLIFFORD B. WALKER**, Los Angeles. The surgical treatment of separated retina
- C. N. SPRATT**, Minneapolis. The cataract operation

Ballroom, Copley Place Hotel—3—Otolaryngology

- A. S. MACMILLAN**, New York. A X-ray Study on Lesions of the Esophagus (statistical study with lantern slides)
- HARRIS P. MONROE**, Philadelphia. Infection of the Esophagus in Acute and Chronic Disease, Fibrosis of the Terminal Portion (Cardiophagnum) Etiology and Treatment
- EDWARD D. CANNIBELL**, The Surgical Approach to the Esophagus

Friday—John Hancock Hall 2—Otolaryngology

- SAMUEL J. KOPETSKY**, New York. Recent developments in the diagnosis of meningitis
- WELLS P. EAGLETON**, Newark, N. J. Meningitis—result of disease of the petrous apex and sphenoidal sinus
- MARVIN I. JONES**, New York. Pathways of approach to the petrous pyramid. Discussion by HARRY P. CANNIBELL
- WILLIAM MITCHELLER**, Cincinnati. When and how shall a nasal sinus inflammation be treated nonsurgically?
- EDWARD C. SCHIFF**, San Francisco. Operative treatment of adenitis, external approach. Discussion opened by CHARLES T. PORTER
- GARYTUL TUTTLE**, Philadelphia. Cancer of the larynx
- HENRY B. OATON**, Newark, N. J. Cancer of the laryngopharynx. Discussion opened by LEROY A. SCHALL

PRELIMINARY PROGRAM FOR EVENING MEETINGS

Presidential Meeting—Monday—October 14 8 15 p m

Address of Welcome ARTHUR W ALLEN M D Boston, Chairman Committee on Arrangements
 Introduction of Foreign Guests FRANKLIN H MARTIN M D, Chicago Director General
 Address of Retiring President WILLIAM D HAGGARD M D Nashville, Tenn
 Inauguration of Officers
 Inaugural Address ROBERT B GREENOUGH M D Boston
 John B Murphy Oration in Surgery DONALD C BALFOUR, M D Rochester, Minn

Tuesday—October 16, 8 15 p m

Living Grafts of Thyroid and Parathyroid Glands HARVEY B STONE, M D Baltimore, with the collaboration of JAMES C OWINGS M D and GEORGE O GUY M D, Baltimore
 Endocrine Mechanisms in Certain Functional Gynecological Disorders. EMIL NOVAK, M.D., Baltimore
 Subject to be Announced JOHN FRASER M D, Ch M F R C S (Edin), Edinburgh Scotland
 Fracture Oration KELLOGG SPEED M D Chicago

Wednesday—October 17 8 15 p m.

Symposium on Congenital Deformities
 Hydrocephalus and Spina Bifida WILDER PENFIELD M D Montreal
 Congenital Deformities of the Genito-Urinary Tract. HERMON C BUMPUS Jr M D Rochester Minn
 Sterility with Special Reference to Surgical Possibilities. BETHEL SOLOMONS, M.D F.R.C.P.I Dublin Ireland
 Diverticulosis and Diverticulitis IRVIN ABELL, M D Louisville

Thursday—October 18 8 15 p m

Symposium on Treatment of Infections
 Infections of Clean Operative Wounds FRANK L MELLENEY M.D New York
 Infections of the Lip and Face. FREDERICK A. COLLIER M D Ann Arbor, Mich.
 Phagedenic Ulcer Its Recognition and Treatment. EMIL HOLMAN M.D San Francisco
 The Repair of Defects Resulting from Full Thickness Loss of Skin from Burns. JAMES B BROWN M.D St. Louis

Convocation—Friday—October 19 8 15 p m

Invocation
 Presentation of Candidates for Fellowship FRANKLIN H. MARTIN, M.D., Chicago Director General
 Conferring of Fellowships. The President
 Conferring of Honorary Fellowships. The President
 Presidential Address. ROBERT B GREENOUGH M D Boston
 Fellowship Address

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY GYNECOLOGY, OBSTETRICS, ORTHOPEDICS UROLOGY
PROCTOLOGY SURGICAL PATHOLOGY ETC.

HARVARD MEDICAL SCHOOL

Monday

- O. KENNETH COOMBS and OTTO AUFRANC—s (Bldg. C).
Demonstration of the mechanical factors controlling
the pulmonary circulation.
CHARLES L. SCUDDER and associates—s (Bldg. E) Sym-
posium on fractures.

Tuesday

Building D—s

- GEORGE B. WIRELOCAL. Studies in mammalian reproduction.
VALY MEVAD. Some problems of inflammation related to
surgery.
HENRY G. SCHWARTZ. An experimental study of synap-
thetic reflexes.
J. L. BREWER. The postnatal growth of the mammalian
lung.
HAROLD L. WEATHEFORD. The first changes in the liver
cells in anaphylactic shock.
LESTER S. KIRD. Some aspects of the hemato-encephalic
barrier.

Building I—

- C. A. BRYNETT and WALTER BAUER. Joint changes
resulting from trauma.
HUBB E. WARD. Streptococcal infections.
CIRIL R. DREWIER. The physiology of the lymphatic
system and its bearing on certain problems in surgery.

Wednesday

Building C—s

- HALLI WELLS DAVIS. Effect of cerebral anemia on the elec-
trical response of the cortex.
M. I. GELBERGHEIM. The use of hypertonic sucrose solution
to reduce cerebrospinal fluid pressure without a sec-
ondary rise.
WALTER H. CANNON. Some relations of the sympathetic
nervous system to surgery.

Building B—s

- DAVID CHIFFERIN. Surgical anatomy of the abdomen, dem-
onstration on cadaver.

Building E—

- FRANK OBER and associates. Orthopedic problems from
Children's Hospital. A. H. BREWSTER. Scoliosis. J.
KIRBY. Posture and postural schools. P. NORMAN.
Posterior transplants. H. FRETZSCHMANN. Congenital
deformities.

Thursday

- CHARLES L. SCUDDER and associates—s (Bldg. E) Sym-
posium on fractures.

Friday

- Symposium on Industrial Surgery—s—Building C.
JOHN D. ADAMS and W. A. ROGERS. Injuries of the back.
HENRY MARBLE, F. J. COTTON and J. D. ADAMS. Injuries
of the nervous system.
F. J. COTTON and J. H. BURNETT. Colles' fracture.

Orthopedic Clinic—s—Building E

- W. GREEN. Osteomyelitis in infants and children.
R. H. MORRIS. Septic hips with involved heads.
A. T. LEON. Osteomyelitis of the tibiae.
R. JORDAN. Multiple myeloma.
A. H. BREWSTER. Pilonidal abscess.
R. H. MORRIS. Knee flexion.

Daily

Warren Museum—M. CANAVAN, Curator—s

- Demonstration of Dwight collection of species illustrating
deformities, anomalies, diseases. Bone tumors, with
X-rays, histories, and microscopic slides, with micro-
scopes available for examination (some of these speci-
mens were used in the illustrations in the monograph
on "Bone Sarcoma," issued by the American College
of Surgeons). Models showing various types of club
feet and effects of operation. Pictures illustrating
pathological conditions of bone in Dr. Nichols' col-
lection. Fractures and dislocations of bones as they
existed before industrial plants provided so many safe-
guards. Tuberculosis of bones and joints. Syphilis of
bones. Dislocation of ends of bones. Collection of old
surgical instruments, obstetrical forceps, trussers for
extracting teeth, urological tools, cupping and leeching
instruments.

FAULKNER HOSPITAL

Wednesday

- F. J. COTTON, E. G. BRACKETT and associates—p. Bone
and joint clinic, operative and dry.
Staff—s. Dry clinic. E. G. BRACKETT. Hip fracture.
F. J. COTTON. Bone tumors, fractures of pelvis.
H. C. MARBLE. Hand surgery. Fractures of the fore-
arm. J. D. ADAMS. Industrial lesions of the knee.
WILLIAM A. ROGERS. Compression fracture of spine.
E. A. CONNOR. Shoulder lesions. B. GOODYER. Os
calci fractures. W. F. COTTON. Ankle fractures.

Thursday

- E. L. YOUNG, JR., R. C. COCHRANE, A. R. KEMPTON and
associates—p. Operative clinic.
J. R. TORBERT and R. S. TITUS—11. Obstetrical clinic.
S. W. WINGG—11. Postoperative pulmonary complica-
tions.
Staff—s. Dry clinic. H. L. JOHNSON. Anesthesia. E. L.
YOUNG, JR. Immunity in peritoneal cavity. R. C.
COCHRANE. Total thyroidectomy. F. G. BALCH, JR.
Infection treatment of hemorrhoids. H. A. SOWLES.
Elbow fractures. Demonstration of X-ray plates and
pathological specimens.

HARVARD UNIVERSITY

(Dillon Field House, Soldier's Field)

Wednesday

- AUGUSTUS THORNTON, JR.—s. Care and prevention of
traumatic injuries in athletics, demonstration of pro-
tective wrapping, padding and apparatus used in
modern athletics.

BOSTON CITY HOSPITAL

Monday

Staff—3 Dry clinic J J REGAN S WEISS and D MUNRO The eye In arteriosclerosis, hypertension and tumor G K COONSE Treatment of shock J REZNICK and M KRIVO Pellegrini-Steida's disease, diagnosis and treatment O J HERMANN and E PARKER, JR. Synovitis of knee. F A SLOWICK Septic hips.

Tuesday

DAVID D SCANNELL, SOMPERS FRASER, THOMAS W WICKHAM and JOHN A SETH—g. General surgical dry clinic.

First Surgical Service—g. General surgical operative clinic. HORACE BURNETT Thoracoplasty for unilateral phthisis phrenicectomy for unilateral phthisis. JAMES J HERTURN Repair of ventral hernia gastric ulcer GEORGE W PAFEN Chronic empyema cholecystitis

Fifth Surgical Service—2 Dry clinic. IRVING J WALKER Some surgical aspects of jaundice—hyperparathyroidism, end results repair of common duct chondrosarcoma of humerus, end result carcinoma of stomach, end result ligation of common carotid artery end result. FRANCIS F HENDERSON Carcinoma of lung pancreatitis, review of sixty cases AUGUSTUS RILEY Prostate and vesicles as foci for retroperitoneal infection kidney resections demonstration of cases. CHARLES C LUND Peripheral arterial embolism, results of operative treatment on fifteen cases E EVERETT O'NEIL Breast tumors, clinical versus x-ray diagnosis WILLIAM A WHITE Subject to be announced.

ROBERT M GREEN, JOHN T WILLIAMS, FREDERICK L GOOD, JOSEPH P COHEN and associates—3 Gynecological and obstetrical dry clinic Treatment of miscarriages puerperal sepsis pelvic inflammation

Wednesday

IRVING J WALKER, FRANCIS F HENDERSON CHARLES C LUND, E EVERETT O'NEIL and WILLIAM A WHITE—g. General surgery operative clinic.

Bone and joint service—g Dry clinic OTTO J HERMANN Boston City Hospital bone and joint service THOMAS H PETERSON Collar fracture therapy Scutter traction In unreduced fractures of the forearm and old shoulder dislocations. GEORGE K COONSE Fracture of the olecranon, new operative repair OTTO J HERMANN Recurrent shoulder dislocations repaired by the Nikola method, end results, discussion WILLIAM F COTTING and MARK H ROGERS Subdeltoid bursitis. MARK H ROGERS Rupture of supraspinatus tendon, discussion. JOSEPH H SHORTTELL Spinal fracture, therapy RUSSELL F SULLIVAN Spinal fusions. OTTO J HERMANN Compound fracture therapy FRANK W MARVIN Anesthesia in fractures.

First surgical service—2. Dry clinic NEWTON C BROWDER Results of treatment of Collar fracture modern splinting methods in fracture therapy JAMES J HERTURN Results in treatment of peptic ulcer giant-cell sarcoma of bone treatment of ventral hernia HORACE BURNETT Methods and results in treatment of acute empyema lung abscess, bronchiectasis, pulmonary tuberculosis. GEORGE W PAFEN Methods and results in treatment of chronic empyema.

Sixth surgical service—3 Dry clinic. JAMES W SEVER Separation of femoral epiphysis. MARK H ROGERS Ankylosed hips. OTTO J HERMANN Treatment of intracapsular fractures of neck of femur demonstra-

tion of cases of recent fractures and ununited fractures FREDERICK J COTTON Pelvic fractures. JOSEPH H SHORTELL Bone grafting ROBERT M GREEN JOHN B WILLIAMS, FREDERICK L GOOD, JOSEPH P COHEN and associates—g. Gynecological and obstetrical operations.

Thursday

OTTO J HERMANN JOSEPH H SHORTELL, WILLIAM F COTTING RUSSELL F SULLIVAN THOMAS H PETERSON and G KENNETH COONSE—g Operative bone and joint clinic. Ward rounds, demonstration of fracture apparatus, etc.

Second surgical service—g. ROBERT C COCHRANE Total thyroidectomy for congestive failure and angina para thyroid tumor. WILLIAM R MORRISON One hundred perforated ulcers of the stomach and duodenum from the Boston City Hospital stomach surgery motion picture demonstration demonstration of following cases—total removal of stomach for cancer with anastomosis of the jejunum to the esophagus, hour-glass deformity of the stomach, cholecystogastrostomy formed by nature. THOMAS K RICHARDS Knee-joint pathology JOHN J LUCY Recurrent intussusception caused by intestinal tumor, carcinoma of the sigmoid. RICHARD L SMITH Pancreatitis. FREDERICK H HOWARD End-results of bilateral renal tuberculosis importance of postoperative treatment of prostatectomized patient.

Fourth surgical service—3 Dry clinic. ARTHUR R KINGTON Civilian gas gangrene tetanus use of amniotic liquid concentrate cavernous hemangioma of neck catheter in common bile duct since 1904 ununited fractures. EDWARD HARDING Demonstration of cases. JOSEPH H BURNETT Collar fracture therapy H A BOUVÉ Acute traumatic abdomen.

Sixth surgical service—3 Bone and joint dry clinic. WILLIAM F COTTING Gonorrheal arthritis of the knee. RUSSELL F SULLIVAN Hallux valgus therapy OTTO J HERMANN Fractures of the os calcis therapy discussion. JOSEPH H SHORTELL Bone tumors FREDERICK W O'BRIEN Pre- and postoperative x-ray therapy in malignant tumors of the bone. THOMAS H PETERSON "Fender" fractures.

ROBERT M GREEN JOHN B WILLIAMS, FREDERICK L GOOD JOSEPH P COHEN and associates—g. Obstetrical and gynecological operations.

Friday

ARTHUR R KINGTON ROBERT C COCHRANE, WILLIAM R MORRISON, STEPHEN P MALLETT and V H KAZAN JIAN—g. General surgery, operative clinic.

Staff—g. Gynecological and obstetrical operations.

Staff—3 Dry clinic. J J REGAN and W B CASTLE The eye In anemic patients. STEPHEN P MALLETT Fractures of the jaw WILLIAM R MORRISON Visualization of arteries and veins for diagnosis and operation of aneurysm ligation of the first part of right subclavian artery and subsequent ligation of innominate artery for arteriovenous aneurysm of internal jugular vein and subclavian artery OTTO J HERMANN and WILLIAM R MORRISON Chronic subluxation of sternal end of clavicle. STEPHEN J MADDOCK Discussion of the Baer maggot treatment of chronic osteomyelitis.

Physiotherapy service—g. Dry clinic. JOSEPH REZNICK Electrodiagnosis. JOSEPH REZNICK, GEORGE W DICKEINSON ARTHUR J COLE, WALDO W ROBBINS and SUZUKI M SIMONS Demonstration of cases and treatment.

MASSACHUSETTS GENERAL HOSPITAL

BOSTON DISPENSARY

Monday

- Staff—2. Dry clinic. A W ALLEN. Bleeding peptic ulcer. JOHN STEWART. Water balance in the surgical patient. C M JONES. Nutritional edema. L S McKITTERICK. Cancer of rectum. E L YOCUM, JR. Cancer of colon. J V MEYER and F W HOTT. Rupture of Graafian follicle and corpus luteum. R H WALLACE. Treatment of burns.
- W J MIXTER, JOHN HODGSON and associates—1. Neuro-surgical clinic.
- V H KALANJAK, E M DALAND and associates—3. Plastic surgery clinic.
- T R GORTALS and associates—4. Obstetrical clinic.

Tuesday

- Staff—9. Operative clinics. General surgical, genito-urinary and thyroid services.
- H C MARBLE and T W HARKER—3. Hand lesions.
- GEORGE HOLMES, A O HAMPTON and associates—1. Symposium on the roentgen ray.
- E D CHURCHILL and associates—1. Surgical research laboratories, demonstration of specimens and discussions.
- M N SMITH PETERSEN and associates—2. Orthopedic clinic.
- Ether Day exercises—4.

Wednesday

- Staff—9. Operative clinics, general surgical, fracture and circulatory services.
- Staff—1. Dry clinic. D KING. Postoperative pulmonary complications. H BRADSHAW. Methods in anesthesiology. H SPRAGUE. Surgery in cardiac patients. L S McKITTERICK and R H MILLER. Ulcerative colitis. E D CHURCHILL. Catholysis. E B BRIDGES. Gastroscopy. R H MILLER. Osteomyelitis.
- J V MEYER, F ALLRIGHT and associates—2. Ovarian dysfunction clinic.
- P D WILSON, A W ALLEN, G A LELAND and associates—1. Fracture clinic.

Thursday

- E A COOMAN and associates—9. Symposium on lesions of the shoulder.
- Staff—9. Operative clinics, general surgical and thoracic services.
- T B MALLORY—12. Clinical pathological conference.
- E D CHURCHILL, W WHITTEMORE and associates—3. Thoracic surgery clinic.
- A W ALLEN and associates—1. Circulatory diseases clinic.
- C C SPENCER and associates—3. Tumor clinic. Cancer symposium.

Friday

- Staff—9. Operative clinics, general surgical and orthopedic services, neurological operations, plastic surgery.
- Staff—1. Dry clinic. C LYONS. Sympiotic infections. B VINCENT and A V BOCA. Surgery of spleen. A W ALLEN. Regional Berta. R H MILLER. Tuberculosis of the lymphatic system. R LINTON. Portal circulation. R H SARGENT. Significance of negative Graham tests. OLIVER CORSE. Subject to be announced. R ROBERTS. Plomodal sinus.
- J H MEYER, A W ALLEN, E D CHURCHILL, R H MILLER, E L YOCUM, JR. and associates—2. Diseases of the thyroid and parathyroid.
- J D BARON and associates—4. Genito-urinary surgery.

Tuesday

- Tumor clinic staff—9. Dry clinic. FRANK W MARVER. Anesthesia in operative cases. CHARLES M PROCTOR. Precancerous and benign lesions of the oral cavity. CHARLES E DUMAS. Radiation technique in malignancy of the throat. LEROY A SCHALL. Treatment of cancer of tonsil. GEORGE S. SPARK. Malignant degeneration of sebaceous cysts. LOUIS E. PHAKTUT. Precancerous lesions and cancer of the cervix, lantern slide demonstration. ALICE ETTINGER. Early diagnosis of malignancy of gastro-intestinal tract by rebiel method. HAROLD A CHAMBERLIN. Papillary tumors of the larynx. RUTH C GRAVES. Management of cancer of penis with particular reference to a modified operation for advanced cases. MITCHELL J HARR. Cancer of the prostatic capsule. LEONARD OLIVER. Management of malignancy of the lymphatic system. HILBERT F DAY. Cancer of breast, end-results of dispassary and personal cases. JOEL ROSENBERG. Bleeding carcinoma of breast without tumor. WILLIAM M SWINNEY. Management of cancer of rectum with particular reference to irradiation. HAROLD McMAURY. Relation of pathology department to tumor clinic.

Wednesday

- Staff—10. Dry clinic. OLIVER G THURMAN. Clinical teaching of third year medical students. FRANCES P BARNUM. Use of adhesive plaster. P A COVALLAS. Adenomatous changes in aberrant thyroid. HILBERT F DAY. Management of a varicose vein clinic, where over 150 treatments a week are given. EDWARD T WHEATLEY. Varicose ulcers, demonstration of cases and treatment. WALTER S LUTZOW. High ligation of varicose veins. WILLIAM M SAYTOW. Injection treatment of varicocele. S SYMCOCK HOWARD. Results of multiple injections of varicose veins at same visit. HILBERT F DAY. Results of excision of sloughs following injection treatment.

Thursday

- Staff—9. Dry clinic. JOHN D ADAMS. Shweller-Christian disease (xanthomatous) bone tumors. ROY E. MARNEY. Chondroma and chondrosarcoma. WILLIAM A HINTON. Detection of syphilis as an aid in practice of surgery. FRANK M TICHOMOV. Syphilis and the differential diagnosis of surgical conditions. JOSEPH SKIDBALL. Ophthalmic studies in syphilis. GRACE E. ROBERTSON. An unusual gynecological condition. LOUIS A O GORDON. Pain in the shoulder girdle. ROBERT W BRUCE. Kidney function renal function tests. WILLIAM E. DAVIS. Some observations on treatment of peptic ulcer in out-patient clinic. ALICE ETTINGER. Diagnosis of activity of duodenal ulcer by X-ray. KATHLEEN S ANDERSON. Hinton hernias. HILBERT F DAY. Solitary gallstone pain relieved by posture. Demonstration of interesting X-ray plates of peptic ulcer and gall-bladder disease.

LAKEVILLE SANATORIUM

Wednesday

- Z. B. ADAMS—9.30. Ankylosis of hip, operative. Ward rounds.
- Staff—3. Dry clinic. Tuberculosis of lymph nodes, genito-urinary tract, eye, gastro-intestinal tract, peritoneum, and skin.
- Z. B. ADAMS—2. Orthopedic dry clinic.

CHILDREN'S HOSPITAL

Monday

F. R. OBER, W. E. LADD and associates—2. Fractures in children.

Tuesday

F. R. OBER and associates—9. Orthopedic operations.

W. E. LADD—9.30. Plastic repair of harelip and cleft palate, demonstration of cases, motion picture demonstration.

THOMAS H. LANMAN—10. Acute osteomyelitis in infancy and childhood.

PATRICK J. MAHONEY—10.30. The use of various types of skin grafts in children's surgery.

HENRY HUDSON JR.—11. Acute appendicitis in childhood. Meckel's diverticulum.

Staff—2. Operative clinic, surgery in infants and children.

Staff—3. Orthopedic clinic. A. T. LEON. Early treatment and the prevention of deformities in poliomyelitis.

F. R. OBER. Shoulder operations. J. W. SEVER. Stabilization of the ankle joint. M. KATZOFF. Tendon transplants. A. T. LEON. Abductor limp.

Wednesday

F. R. OBER and associates—9. Orthopedic clinic at Peabody House.

Staff—9.30. Operative clinic.

W. E. LADD—4. Congenital hypertrophic pyloric stenosis. Intussusception. diagnosis and treatment.

DONALD W. MACCOLLUM—3.30. Treatment of undescended testes, end-results over a 34 year period.

THOMAS H. LANMAN—3. Chronic pulmonary suppuration, demonstration of cases.

HENRY HUDSON JR.—3.15. Empyema in childhood, its treatment.

SIMNEY FARRER—3.30. Surgical pathology of malignant tumors in infancy and childhood, followed by demonstration of pathological specimens in department of pathology.

EDWARD C. VOOR—3.45. Roentgenological studies of unusual bone tumors in infancy and childhood.

Thursday

F. R. OBER and associates—9. Orthopedic operations.

W. E. LADD—9.30. Intestinal atresia, diagnosis and treatment, demonstration of cases, lantern slide demonstration.

PATRICK J. MAHONEY—10. Types of tracheo-oesophageal fistulae—differential diagnosis and operative treatment, congenital and acquired oesophageal stricture, demonstration of methods of dilatation.

W. E. LADD—10.30. Atresia of the bile ducts, diagnosis and treatment. choledactus cyst, diagnosis and treatment.

THOMAS H. LANMAN—11. Ureteral transplantation for atrophy of the bladder. demonstration of treated cases.

Staff—2. Operative clinic, surgery in infants and children.

Staff—3. Orthopedic dry clinic. A. H. BREWSTER. Claw feet. F. H. MORRIS. Torticollis, misused approach. H. FITZSIMMONS. Discussion. F. R. OBER. Semilunar cartilage. H. FITZSIMMONS. Osteoclasts. R. H. MORRIS. Club feet.

Friday

Staff—9. Orthopedic clinic. S. M. FITCHET. Cleidocranial dysostosis. F. R. OBER. Shelf operations. Sprengel's deformity. S. M. FITCHET. Flexion deformity of the hips. A. T. LEON. Coxo plana. J. W. SEVER. Obstetrical paralysis.

Staff—9.30. Operative clinic, surgery in infants and children.

W. E. LADD—2. Acute and chronic lymphadenitis, demonstration of cases, lantern slide demonstration.

PATRICK J. MAHONEY—2.30. Treatment of fresh burns.

DONALD W. MACCOLLUM—2.45. Treatment of hemangiomas by endothermy, demonstration of cases.

W. E. LADD—3. Surgical significance of pyuria in infancy and childhood. demonstration of cases, lantern slide demonstration.

T. H. LANMAN—3.30. Malignant bladder tumors in childhood.

PETER BENT BRIGHAM HOSPITAL

Monday

DAVID CHEEVER—2. Surgical clinic.

H. F. NEWTON—3. Thoracoplasty.

S. A. LEVINE—3.30. Circulatory emergencies in surgical patients.

Tuesday

Staff—9. General surgery operative clinic.

E. C. CUTLER—2. Total thyroidectomy.

C. L. DERRICK—3. Symptoms and diagnosis of vascular thrombosis.

JOHN HOMANS—3.30. Swollen legs.

Wednesday

Staff—9. General surgery operative clinic.

HENRY A. CHRISTIAN—2. Medical clinic.

M. C. SOMMER—3. Recent developments in diagnostic radiology.

E. S. EMERY JR.—3.30. Results of surgical procedures for relief of peptic ulcer.

Thursday

Staff—9. General surgery operative clinic.

W. C. QUIMBY—2. Indications for and results of total cystectomy.

J. C. ECKLES and G. P. GRANTFIELD—2.30. Denervated kidney studied by means of the divided bladder.

M. S. STROCK—3. Methods of fixation of fractures of the jaw.

S. B. WOLBACH—3.30. Demonstration of surgical pathology.

Friday

Staff—9. General surgery operative clinic.

DAVID CHEEVER—2. Cancer of the stomach.

F. C. NEWTON—2.30. Cancer of the rectum.

R. FITZ—3. Function of the spleen.

W. P. MURPHY—3.30. Treatment of pernicious anemia, motion picture demonstration.

F. R. OBER—3.45. Treatment of neuromuscular sequelae of pernicious anemia.

MALDEN HOSPITAL

Wednesday

L. E. PRASEUT and A. A. GALLAGHER—9. Gynecological operations.

R. SULLIVAN—9. Orthopedic clinic.

L. W. McQUIN—9. Amebic dysentery and its complications.

C. F. LYNCH, D. J. DOUGAN, I. J. WALKER and F. W. GAY—2. Surgical operations.

Staff—2. Dry clinic. J. S. ROONEY. Pathological demonstration. I. J. WALKER. Discussion of jaundice with demonstration of liver specimens. L. SILVA. Discussion of coronary and gall-bladder disease in middle-aged people with electrocardiographic tracings. C. H. STAPLES. Hyperpituitarism, demonstration of cases.

NEW ENGLAND DEACONESS HOSPITAL

Tuesday

F H LAKEY H M CLUTE, R B CATTELL and R. H. OVERHOLT—*General surgical operations*
 GILBERT HORRAX and JAMES POTTER—*Neurosurgical operations*
 RICHARD H OVERHOLT—*Thoracic surgery operations*
 G E HAGGART—*Orthopedic operations*
 JAMES B HICKS—*Urological operations*
 LORCOLA F SKEE, PHILIP D WOODBRIDGE and URBAN EVERSOLE—*Anesthetics*
 F H LAKEY—*Esophageal diverticulum, dry clinic*
 GILBERT HORRAX—*Malignant erythematism, dry clinic*
 Staff—*Dry clinics* H M CLUTE Management of obstructive jaundice exploration of common duct
 GILBERT HORRAX Brain tumors malignant cephalothalms
 SARA M JORDAN Gastric cancer and ulcer
 gastroduodenal ulcer
 F H LAKEY Total gastrectomy for cancer
 gastroduodenal colic fistula, surgery of intractable ulcer
 EVERETT KEEFER Hemorrhage in peptic ulcer
 RICHARD B CATTELL Embolotomy parathyroid tetany

Wednesday

F H LAKEY H M CLUTE, R B CATTELL and R. H. OVERHOLT—*General surgical operations*
 GILBERT HORRAX and JAMES POTTER—*Neurosurgical operations*
 RICHARD H OVERHOLT—*Thoracic surgery operations*
 G E HAGGART—*Orthopedic operations*
 JAMES B HICKS—*Urological operations*
 LORCOLA F SKEE, PHILIP D WOODBRIDGE and URBAN EVERSOLE—*Anesthetics*
 Staff—*Dry clinics* G E HAGGART Subdeltoid bursitis, treatment of flexion deformities
 JAMES L POTTER End results in trigeminal neuralgia spinal fluid pressure dynamics
 FRANK H LAKEY Esophageal diverticulum hyperthyroidism
 H M CLUTE End results in hyperthyroidism
 LEWIS M HICKERL Thyrocardiac patients
 EVERETT KEEFER Ulcerative colitis
 RICHARD B CATTELL Surgical treatment of ulcerative colitis
 RICHARD OVERHOLT Limited thoracoplasty in pulmonary tuberculosis
 cancer of lung

Thursday

E P JOSELY H F ROOT L S MCKITTERICK and T C PRATT—*Surgical and medical diabetic ward rounds*
 T C PRATT—*30 Thigh amputation for diabetic gangrene*
 L S MCKITTERICK—*30 Gritti Stokes amputation for diabetic gangrene*
 Staff—*Dry clinic* Surgery in diabetes mellitus
 E P JOSELY Medical care of the surgical patient
 L RICHARDS Otolaryngological aspect of diabetes
 J H WATTS Cataract surgery in diabetes mellitus
 Gangrene and infection of the lower extremities
 H F ROOT preventive measures
 L S MCKITTERICK, factors influencing the level of amputation
 T C PRATT indications for guillotine amputation
 R S TITUS Obstetrics in diabetes
 MARK ROGERS Depressed fracture of the spine in diabetes
 subdeltoid bursitis in diabetes mellitus

Friday

F H LAKEY H M CLUTE, R B CATTELL and R. H. OVERHOLT—*General surgical operations*
 GILBERT HORRAX and JAMES POTTER—*Neurosurgical operations*
 RICHARD H OVERHOLT—*Thoracic surgery operations*
 G E HAGGART—*Orthopedic operations*

JAMES B HICKS—*Urological operations*

LORCOLA F SKEE, PHILIP D WOODBRIDGE and URBAN

EVERSOLE—*Anesthetics*

Staff—*Dry clinics* R B CATTELL Cancer of the colon and rectum
 GILBERT HORRAX Root resection for trigeminal neuralgia
 cordotomy for pain
 JAMES POTTER Spinal cord tumors
 RICHARD OVERHOLT Cancer of the breast
 JAMES B HICKS Transurethral resection of the prostate
 H M CLUTE Subphrenic abscess
 F H LAKEY and FRANK N ASLANI Parathyroid tumors

CAMBRIDGE CITY HOSPITAL

Tuesday

H H GERMAIN D F MANDREY L J O'BRIEN, J J MURPHY and L D D'ERICO—*General surgical clinic, operative and dry*
 H H GERMAIN Results in surgery of the shoulder nerve suture and skin graft following burn
 arthroplasty of lower jaw
 D F MANDREY Fracture of pelvis and humerus
 E J O'BRIEN Results of transurethral resection of prostate
 misadventure of cerclum in child 2½ years old
 results in cases of spina bifida
 F W O'BRIEN Traumatic spine and head injuries, demonstration of X-ray films
 B A GORDON and WALDO ROSSIGNOL Orthopedic and fracture clinic
 E D'ERICO—*Injection treatment for aneurysms veins and aorta, presentation of cases and motion pictures*
 L DOWNEY—*Injection treatment of hemorrhoids, demonstration of cases*

Wednesday

H H GERMAIN—*General surgical operations*
 Staff—*Dry clinic* MAXWELL MACDONALD Encephalography as an aid to diagnosis in cerebral lesions
 F G MANDREY and T E DRYAN Results of accessory sinus operations, demonstration of cases
 R D YOUNG Cranial section
 F J LYNN Subject to be announced later
 J J MURPHY Treatment problems of burns in a general hospital
 J W ROCKWELL Oral surgery operations
 ARTHUR SANDSTADT and WILLIAM LAMOND Orthopedic and fracture clinic
 F O O'BRIEN Traumatic spine and head injuries, demonstration of X-ray films
 J W ROCKWELL and F MCLAM Fractures of lower and upper jaw
 M SIEGA Arthroplasty of lower jaw
 E J O'BRIEN and L ROCKWELL—*30 General surgical operations*
 E D'ERICO—*Acute torsion of great omentum; appendicitis complicating pregnancy*

Thursday

D F MANDREY—*General surgical operations*
 J J MURPHY—*10 30 General surgical operations*
 Problem of rupture of urethra, fracture of pelvis, fracture of femur
 F O O'BRIEN—*11 Traumatic spine and head injuries, demonstration of X-ray films*

WALTHAM HOSPITAL

Friday

R L DENORMANDE, T W HARNER, D MUNRO J D BARNY, J W SEVER, H Q GALLUP, R COLLINS and H A WOOD—*General surgical operations*
 R L DENORMANDE, T W HARNER, D MUNRO, J D BARNY, J W SEVER, H Q GALLUP, R COLLINS and H A WOOD—*Dry clinics*
 General surgery orthopedics, obstetrics, pathology etc

BETH ISRAEL HOSPITAL

Monday

Staff—30. Dry clinic. J SEARS Prophylactic vein ligation against embolism from phlebitis of the internal saphenous vein. M BLOOMBERG The prevention of scar tissue by use of baudruche, experimental and clinical experiences, demonstration of cases. W LEVENSON Intraperitoneal adhesions. L HERMANSON Transfusions during active bleeding from peptic ulcer. A THURMAN Surgical treatment of cholecystitis. J MEIER Subacute pancreatitis. J FINE Postoperative distention, an experimental study

Tuesday

Staff—0 Symposium on total thyroidectomy for chronic heart diseases and angina pectoris. H BLUMGART Rationale of total thyroidectomy in chronic heart disease. J RISEMAN End results of total thyroidectomy in angina pectoris. D DAVID End results of total thyroidectomy in congestive heart failure. H. BLUMGART Indications and contra indications for surgery selection of cases. C. G. MIXTER General surgical considerations in total thyroidectomy. D BURLIN Technical considerations in total thyroidectomy. DOROTHY GILLIGAN Postoperative parathyroid tetany. D DAVIS Treatment of postoperative complications. J FINE A technique for relief of temporary bilateral recurrent nerve injury. A WEINSTEIN and M. ALTSCHULE Total thyroidectomy motion picture demonstration demonstration of cases. C. G. MIXTER and associates—2 Surgical operations including total thyroidectomy

Wednesday

C. G. MIXTER and associates—0 Surgical operations.
Staff—10 30. Dry clinic. W. DANKSBERG Blood changes in surgical conditions. DR. MORRISON Medical conditions simulating surgical disease. DR. DEKOW Significance of postoperative rise in nonprotein nitrogen. ARNOLD STARR and DR. MUELLER Postoperative renal suppression. C. G. MIXTER Surgery of the large intestine. S. CARROLL and DR. FALCON LEASES Thyroid clinic experiences, demonstration of cases.
E. G. CRABTREE and associates—0. Dry clinic genitourinary surgery. Symposium on the female bladder. Demonstration of various factors related to function in health, pregnancy and disease. use of urethrogram and cytogram in diagnosis of bladder displacements and deformities in the multiparous woman, results of routine surgery. treatment of infections in the abdominal bladder.
Staff—3 Dry clinic. C. BEARSE Acute appendicitis beyond age of fifty. W. J. MIXTER Subject to be announced. B. RAPAPORT Comparison on postoperative complications following spinal and general anesthesia. J. FINE Relation of diaphragm to the efficiency of cough. L. NABOK Gas bacillus infection complicating laparotomy. B. BAXBY Differential diagnosis of jaundice. DR. JANKELSON Indications for ileostomy in ulcerative colitis. C. G. MIXTER Regional ileitis. M. BARKER Is radical resection for carcinoma of rectum the best procedure?

Thursday

Staff—0. Symposium on total thyroidectomy for chronic heart disease and angina pectoris. H. BLUMGART Rationale of total thyroidectomy in chronic heart disease. J. RISEMAN End results of total thyroidectomy in angina pectoris. D. DAVIS End results

of total thyroidectomy in congestive heart failure. H. BLUMGART Indications and contra indications for surgery selection of cases. C. G. MIXTER General surgical considerations in total thyroidectomy. D. BURLIN Technical considerations in total thyroidectomy. DOROTHY GILLIGAN Postoperative parathyroid tetany. D. DAVIS Treatment of postoperative complications. J. FINE Technique for relief of temporary bilateral recurrent nerve injury. A. WEINSTEIN and M. ALTSCHULE Total thyroidectomy motion picture demonstration demonstration of cases.

C. G. MIXTER and associates—2 Surgical operations including total thyroidectomy

E. G. CRABTREE and associates—2 Bladder surgery operative and dry clinic.

Friday

C. G. MIXTER and associates—0. General surgical operations.

W. J. MIXTER—0. Craniotomy

MARK H. ROOKER and associates—0 Orthopedic dry clinic Manipulation of subdeltoid bursitis, methods and results slipping epiphysis, femoral neck club foot, demonstration of application of plaster cast method of drainage of septic knee, posterior ischial stimooling tenovaginitis, operative results. Nicola operation, end-results in cases of recurrent dislocation of shoulder, marble bones, repeated fractures of femur fractures of long bones in Paget's disease compression fractures of spine in diabetes and old age correction of hallux valgus, temporary paralysis of sensory nerve affecting the joint.

E. G. CRABTREE and associates—2 Renal surgery

Staff—2 Symposium on tumors. WILLIAM DANKSBERG Malignancy of blood forming organs. L. M. FREIDMAN and H. F. FREIDMAN Laryngeal carcinoma, diagnosis and treatment presentation of cases. R. DAVIDOFF C. G. MIXTER and H. F. FREIDMAN Breast tumors, differential diagnosis, surgical and radiation treatment. DR. SCHLESINGER Diagnosis of malignancy from sputum and pleural fluids. H. F. FREIDMAN and R. DAVIDOFF Policy toward married women in regard to carcinoma of the uterine cervix. S. A. ROBBINS, E. G. CRABTREE and G. E. PRATHER Renal tumors, roentgen diagnosis, surgical treatment results. G. E. PRATHER Testicular tumors. J. H. SCHWARTZ and H. F. FREIDMAN Carcinoma of the skin diagnosis, motion picture demonstration of radium treatment.

Daily Exhibit in Medical Research Laboratories

Blood changes to surgical conditions. total thyroidectomy for chronic heart disease. renal function tests in surgery demonstration of interesting and unusual X ray films. surgical pathological specimens with case histories, photographs, etc.

LONG ISLAND HOSPITAL

Wednesday

R. H. MORRIS and T. H. PETERSON—0 Fracture demonstration

H. R. VIETS—0 Neurosurgical diagnosis.

J. H. CUNNINGHAM and C. S. SWAN—0 Urological operations.

A. S. MACMILLAN—2 X ray demonstration

L. B. ALEXANDER—2 Pathological demonstration.

C. L. SWAN R. I. SMITH and T. C. PRATT—2 General surgical operations.

ST ELIZABETH'S HOSPITAL

Tuesday

- JOSEPH STANTON—9 Subtotal thyroidectomy
 GEORGE KILMAN—9 Hysterectomy
 CHARLES KILMAN—9 Supravaginal hysterectomy
 E. J. O'BRYEN—9 Transurethral resection of prostate gland
 E. M. McDONALD—10 Repair of postincisional hernia with peritoneal fascial strips, by utilizing sac
 JOHN SPELLMAN—10 Radical operation for cancer of tongue
 THOMAS BROOKER—10 Spine fusion
 BENEDICT BOLAND—11 Low transverse cervical section
 LAURENCE LOUIS—11 Total thyroidectomy
 Staff—3 Dry clinic CHARLES KILMAN Series of spontaneous rupture of the uterus. RUSSELL SULLIVAN End-results of bone and joint problems. LAURENCE LOUIS Postoperative total thyroidectomy for (a) angina pectoris, (b) congestive heart disease. FRANCIS P. MCCARTHY Frozen sections demonstration and discussion of pathological specimens

Wednesday

- JOSEPH STANTON—9 Hysterectomy
 GEORGE KILMAN—9 Cholecystectomy
 RUSSELL SULLIVAN—9 Nikolski operation for recurrence of dislocation of shoulder
 LAURENCE LOUIS—9 Radical operation, cancer of breast
 E. J. O'BRYEN—10 Nephrectomy for tuberculous kidney
 WILLIAM McDONALD—10 Operation for correction of childhood injury
 THOMAS BROOKER—11 Reconstruction of hip joint
 M. MCCARTHY—11 Removal of cartilage from knee joint
 EDWARD McDONALD—11 Repair of recurrent inguinal hernia with fascial strips
 MARTIN SPELLMAN—11 Sacro-diac arthrodesis
 Staff—3 Dry clinic WILLIAM DOWAN Industrial surgery. J. W. WINKLER Diseases of the gall bladder medical cases with reference to operation or being surgically unsuit. Demonstration of cases. FRANK JANTZEN Cholecystitis and biliary dysfunction (a) with hypopituitary syndrome, (b) with hypothyroid syndrome. MICHAEL MCCARTHY Hip graft in reconstruction of foot joint. ASA Disease of spleen from a surgical standpoint. THOMAS BROOKER Demonstration of spinal cases with operative technique, lantern slides

Thursday

- JOSEPH STANTON—9 Gastro-enterotomy
 BRYANT WETHERILL—9 Nephrectomy
 FRANK JANTZEN—9 Inguinal herniomy under local anesthesia
 EDWARD McDONALD—9 Gastro-enterotomy
 THOMAS BROOKER—9 Reconstruction of hip joint
 CHARLES KILMAN—10 Prolapsing uterus with perineal repair and suspension
 WILLIAM DOWAN—10 Suprapubic prostatectomy
 EDWARD O'BRYEN—10 Suprapubic cystostomy
 MICHAEL MCCARTHY—11 Fascial repair of double recurrent inguinal hernia
 BENEDICT BOLAND—11 Tubal plastic for sterility
 Staff—3 Dry clinic WILLIAM O'HALLORAN Medicine from a pre-operative and postoperative standpoint. BRYANT WETHERILL Discussion of diagnosis of carcinoma of bladder. WILLIAM McDONALD Polyhydramnios in pregnancy. JAMES LYONS Vulval phlebitis complicating pregnancy. BENEDICT BOLAND Hypocalcemia of unusual origin, gastric ulcer demonstration of interesting clinical cases.

NEWTON HOSPITAL

Tuesday

- E. D. LEONARD—9 Breast amputation
 G. M. MORGAN—9 Reconstruction of elbow
 O. K. COOMER—9 Operation for fractured patella
 L. G. CHARTER—9 Cystostomy
 F. W. MARTIN—9 Paracocain anesthesia
 D. G. NUTTER—9 15 Desmoid cysts of the abdomen
 R. I. SMITH—9 30 Carcinoma of the duodenum
 G. C. PRATHER—9 30 Renal calculus
 N. P. BRACKETT—10 Strangulated hernia in the aged
 D. G. NUTTER—10 Hysterectomy for fibroids
 G. K. COOMER—10 Trocar repair of olecranon fracture
 G. M. MORGAN—10 Ankle fractures
 F. R. CLARK—10 Cesarean section
 H. WATKINS—10 15 Intussusception in infancy
 D. G. WILCOX—10 30 Pyomyositis
 E. D. LEONARD—10 45 Paralytic ileus
 R. I. SMITH—11 Complete thyroidectomy for angina pectoris
 N. P. BRACKETT—11 Cholecystectomy
 H. G. DUFFY—11 Ligation of sphenous vein for varicose ulcer
 Fracture and Orthopedic services—9 Dry clinic Demonstration of application of plaster casts, Boehler technique application of Anderson well leg traction apparatus. Treatment of fractures of the spine, including hyperextension, frames, jackets, etc. Treatment of Colles fracture by Cotton-Lader method demonstration of new type humeral traction abduction splint
 Staff—2 Symposium on obstetrics. L. GRANTVILLE CHARTER Discussion of urinary tract infection in pregnancy. GEORGE C. PRATHER Discussion of loose kidneys in pregnancy. F. R. CLARK, M. T. ELLER and G. L. MAY Pre and postoperative care of patients. ROBERT G. VANCE—2 X rays of traumatic skulls.

COLLIS P. HUNTINGTON MEMORIAL HOSPITAL

Monday

- Staff—2 15 Tumors and diseases of bones, dry clinic. J. C. ABB Calcium metabolism in diseases of the bones. CHARLES C. STINSON Malignant tumors of bone. RICHARD DREMPER Radiological diagnosis of bone tumors and certain rare forms of skeletal diseases. C. C. FRANKLIN The phosphate determination in bone tumors and skeletal diseases
 GEORGE A. LEONARD and J. V. MILES—2 15 Carcinoma of the cervix

Wednesday

- Staff—2 15. Carcinoma of the oral mucous membrane, dry clinic. CHARLES C. STINSON Choice of treatment in the individual case. C. C. LUND Results of treatment of cancer of lip. GRANTVILLE W. TAYLOR Carcinoma of the mouth in the female. RICHARD DREMPER Radiation treatment of oral cancer. CHARLES H. HOWLAND Prophylaxis of cancer of the mouth. SORINUS STURGIS Electrical currents between fillings of different metals as an etiological factor in leukoplakia and cancer of the mouth.
 CHARLES C. STINSON, GRANTVILLE W. TAYLOR and RICHARD DREMPER—2 15 Cancer of the breast

MASSACHUSETTS MEMORIAL HOSPITAL

Daily

- Staff—9 Operative clinics.
 Staff—2 Dry clinics.

PALMER MEMORIAL HOSPITAL

Tuesday

Staff—9. Treatment of malignant disease including surgery, electro-surgery and radium implantation operative clinic.

Staff—3. Dry clinics. G. A. LELAND. Carcinoma of cervix. FLETCHER COLBY. Urinary tract complications from carcinoma of the cervix. L. S. MCKITTERICK. Intestinal radiation for carcinoma of the breast. R. H. DEXTER. Irradiation of the ovary in cancer of the breast. GEORGE G. SMITH. Diversion of the urinary stream. JOHN HODGSON. Relief of pain in malignant disease.

Wednesday

Staff—9. Treatment of malignant disease including surgery, electro-surgery and radium implantation, operative clinic.

Thursday

Staff—3. Dry clinics. D. F. JONES. Surgical management of carcinoma of the rectum. L. S. MCKITTERICK. Factors favoring early diagnosis of cancer of the colon, principles of treatment. R. H. SWEET. Polyps of the colon. SHIELDS WARREN. Pathological aspects of rectal polyp. WYMAN RICHARDSON. Blood dyscrasias after gastrectomy and short-circuiting operations on the intestinal tract.

Friday

Staff—9. Treatment of malignant disease including surgery, electro-surgery and radium implantation, operative clinic.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

Tuesday

Staff—9. Surgical operations.

Staff—2. Dry clinic. Carcinoma of fundus in young woman treated for amenorrhea with antitumor-S. fibrosarcoma of liver in six year old child. carcinoma of kidney with metastasis in three year old child. unusual pathological specimens with case histories.

Wednesday

Staff—9. Surgical operations.

Staff—9. Obstetrical analgesia demonstration of cases ward rounds pre-natal clinic; parent-teaching clinic.

Thursday

Staff—9. Surgical operations.

Staff—9. Orthopedic operations demonstration of unusual case of fractured pelvis.

MIRIAM KATZ—9. Familial muscular dystrophy.

Friday

Staff—9. Surgical operations.

STATE PRISON COLONY

Day to be announced

HILBERT DAY. Practice of medicine in a modern correctional institution.

WILFRED BLOOMBERG. Psychiatric approach to prison medicine.

HENRY R. CRAIG. Unusual incidence of peptic ulcer in a prison population.

GEORGE H. LYONS. Minor surgical injuries in a protected population.

GEORGE ROTHSBLATT. Dental conditions causing personality changes.

FREE HOSPITAL FOR WOMEN

Tuesday

F. A. PEMBERTON, G. V. SMITH and S. C. GRAVES—9. Operative and dry clinic. Carcinoma of cervix uteri treatment and results, prevention diagnosis of early cases, relation to cervicitis and its treatment complications of radium treatment, relief of pain carcinoma of fundus uteri, treatment and results, classification other tumors of uterus—fibroids, adenomyoma.

Wednesday

F. A. PEMBERTON, G. V. SMITH and PAUL YOUNCE—9. Operative and dry clinic. Tumors of the ovary diagnosis, treatment and results. Cyst adenoma, granulosa cell tumor, Brenner tumor, teratoma, endometriosis, diagnosis and treatment, tumors of tubes, round ligaments and vagina.

Thursday

G. V. SMITH and JOHN ROCK—9. Operative and dry clinic. Sterility diagnosis treatment and results. Menorrhagia and metrorrhagia, diagnosis, treatment and results. Endocrine research dysmenorrhea.

Friday

F. A. PEMBERTON, E. B. SHEEHAN and S. C. GRAVES—9. Operative and dry clinic. Prolapse, procidentia, complete tear of perineum, vesico- and rectovaginal fistula, kraurosis vulvae, carcinoma vulvae, trichomonas vaginalis, tumors of breast, value of X ray treatment.

NEW ENGLAND BAPTIST HOSPITAL

Tuesday

HAILEY B. LODGE—9. Operative clinic.

Staff—9. Dry clinics. HAILEY B. LODGE. Portal thrombosis, ulcerative colitis, gall stones, pancreatitis, uterine fibroids. A. A. HOBBS. Ulcerative colitis. ROBERT L. DENORMANDIE and DELOS J. DENTON. Blood transfusion in obstetrics management of borderline obstetrical cases anesthesia and analgesia in obstetrics prevention of eclampsia.

Thursday

F. H. LAHEY, H. M. CLOUT, R. B. CATTRELL and R. H. OVERHOLT—9. General surgery operative clinic.

GILBERT HORRAX and JAMES POPPEN—9. Neurosurgical operations.

G. E. HAGGART—9. Orthopedic surgery.

JAMES B. HICKS—9. Urological surgery.

LINDOLN F. SHEP, PHILIP D. WOODBRIDGE and URBAN EVERSOLE—9. Anesthesia.

BOSTON LYING-IN HOSPITAL

Tuesday and Thursday

FREDERICK C. IRVING and associates—9. Obstetrical operations demonstrations of premature nursery, X-ray department, research laboratories and hospital wards.

FREDERICK C. IRVING and associates—3. Dry clinic. Fetal roentgenometry; anemia in pregnancy; treatment of heart disease in pregnancy; treatment of diabetes in pregnancy; management of neglected cases of cephalopelvic disproportion; treatment of placenta previa; separation of the symphysis pubis; kidney function tests in pregnancy; classification of the albuminuric and hypertensive conditions in pregnancy; factors which make for viability in premature infants; erythroblastosis fetalis; barbiturates and other analgesic drugs in labor.

ROBERT B BRIGHAM HOSPITAL

Monday

- L. M. SPEAR—2. Classification of types of arthritis
L. T. SWAIN and J. KUTNER—3. Treatment and orthopedic principles involved in arthritis

Tuesday

- H. K. THOMPSON—2. Clinical analysis of arthritis with reference to classification and treatment.
P. D. WILSON and S. ROBERTS—3. Discussion of operative procedures, demonstration of end-results

Wednesday

- L. M. SPEAR—2. Classification of types of arthritis
L. T. SWAIN and J. KUTNER—3. Treatment and orthopedic principles involved in arthritis

Thursday

- H. K. THOMPSON—2. Clinical analysis of arthritis with reference to classification and treatment
P. D. WILSON and S. ROBERTS—3. Discussion of operative procedures, demonstration of end-results

EVANGELINE BOOTH MATERNITY HOSPITAL

Wednesday

- A. K. PADGE, H. S. FRYKEL, W. J. McDONALD, M. G. BEEBLEN, J. HOPKINS, D. GOLDFARB, A. A. LEVI, J. J. CONWAY, H. BAKER, S. OGDON and R. T. PHILLIPS—9. Gynecological operations and obstetrical procedures

Staff—2. A review by demonstration, charts, pictures and exhibits of the obstetrical experience of the Booth Hospital. Maternal mortality factors responsible for the declining rate at the Booth Hospital: the bleeding cases, decubiti, management and results, obstetrical asphyxia, asphyxia, analgesia and anesthesia in labor results from the standpoint of safety, efficiency, effects on operant incidence. Cesarean section, incidence, indications and mortality, toxemia of pregnancy, treatment methods and results over a fourteen year period, "debunking" pelymetry heart disease complicated by pregnancy, fetal mortality analysis of four hundred cases, pathology

INDUSTRIAL SURGERY

Tuesday

- H. C. JARVILLE and H. P. TOWLE (42 Berkeley Street)—9
D. LYNCH and B. GOODY (245 State Street)—9

Wednesday

- G. W. MORSE (31 St. James Avenue)—9.

Thursday

- WILLIAM DOLAN (10 Milk Street)—9

Friday

- J. H. SHORTKILL (200 Tremont Street)—9
D. LYNCH and B. GOODY (245 State Street)—9.

CARNEY HOSPITAL

Daily

- F. H. LYND and associates—9. General surgical operations.
L. E. PHAYREY and associates—9. Gynecological and obstetrical operations
W. R. MACAULAND and associates—9. Orthopedic operations
R. S. GRAVES and associates—9. Urological operations.
Staff—15. Dry clinic

PONDVILLE STATE CANCER HOSPITAL

Tuesday—2 p.m.

- ERNEST M. DALAND. The Massachusetts cancer program
HERBY JACKSON, Jr. Some aspects of malignant lymphoma.
JOE V. MEYER. Ovarian tumors
LAWSON PARSONS. Treatment of cancer of the cervix by X-ray followed by radium
ROGER GRAVES. Cancer of the prostate with metastases.
CHARLES KIRKHAM. Cancer of the penis.

Friday—2 p.m.

- GRANTLEY TAYLOR. Radium needles in cancer of breast.
HOMER ROGERS. Chronic cystic mastitis
RICHARD DREHER. X-ray in the diagnosis of gastrointestinal cancer.
SHELTON WARREN. Changes in tumor tissue caused by radiation
JOHN HODGSON. Treatment of pain in cancer patients.
CARL EMMERSON. Cancer of the antrum

MASSACHUSETTS WOMEN'S HOSPITAL

Thursday

- HENRY T. HUTCHINGS—9. Panhysterectomy
STEPHEN RUSSELL—9. Plastic laparotomy
WILLIAM A. WHITE, JR.—9. Laparotomy
REYNOLD MARCHAND—9. Transverse cervical Cesarean section.
ROBERT L. MASON—9. Thyroidectomy
Staff—3. Dry clinic. CHARLES H. LAWRENCE. Endocrine sterility, end-results. DONALD MACDONALD. Problems of sterility. CHARLES F. PANTIER. Congenital obstruction of dislocation of right hip. Causes of obstruction of bone. J. STEWART ROBERTS. Pathological specimens.

CHELSEA MEMORIAL HOSPITAL

Thursday

- Staff—9. Dry clinic. CHARLES F. SKELDON. Septic abortions. LILWILLIAM H. ROCKWELL. Perforated duodenal ulcer. GEORGE A. MARSH. Acute appendicitis with peritonitis. SYLVESTER B. KELLEY. Causes of death in prostates.
Staff—3. General surgical operations
Staff—3. Dry clinic. GORDON MORENO. Abdominal trauma. G. STEPHEN JONES. Volkmann's contracture. ALEXANDER P. AITKEN. Epiphyseal separation of the radius. JOHN S. HODGSON. Fractures of the skull. Discussion by L. KENNEDY, J. COTTON

CAMBRIDGE HOSPITAL

Tuesday

- Staff—9. General surgical clinic.
Staff—3. General surgery dry clinic

Wednesday

- J. W. SEVER and associates—9. Fracture clinic.
V. H. KALANJIAN—9. Corrective fracture clinic.
Staff—3. Fractures, dry clinic

SYMES ARLINGTON HOSPITAL

Tuesday

- F. J. COTTON—9. Bone and joint surgery
A. L. BRITT—9. Tumor of the spinal cord shoulder arthrodesis.
G. P. TOWLE—9. General surgery.
S. G. JONES—9. Volkmann's paralysis

SURGERY OF THE EAR, NOSE AND THROAT

MONDAY

- H. DAVIS, H. A. DENBYSHIRE and M. H. LURIE—Harvard Medical School, Bldg C—3 Physiological experiments on the hearing of animals with the technique first reported by Wever and Bray, report of the pathological conditions found in animals with abnormal hearing demonstrating technique and apparatus used. Physiological experiment conducted on animal with the apparatus used, demonstrating: (1) auditory response obtained from the cochlea itself (2) auditory response from the cochlear nerve and its various ganglion centers in the midbrain (3) auditory response as obtained from the cortex of the animal in the temporal lobe (4) the effect of anesthetics on these electrical responses (5) demonstration of masking of tones in the cochlea
- F. E. GARLAND—Harvard Medical School, Bldg B Demonstration of historical instruments.

TUESDAY

- Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases
- WALTER B. HOOVER—New England Deaconess Hospital—9 Osteoma of sinuses. Laryngeal and tracheal complications of thyroid surgery. Lingual tonsils and lateral bands of pharyngeal lymphoid tissue. Syndrome of anemia, glossitis and dysphasia.
- J. W. ROCKEY and T. E. DIMAN—Cambridge City Hospital—9 Tonsillectomies with gas-oxygen anesthesia. Presentation of cases of lateral sinus thrombosis
- F. G. MINTZER and associates—Carney Hospital—9 Operation and demonstration of cases.
- WILLIAM T. HALLEY—St. Elizabeth's Hospital—11 Operation for correction of dislocation of nasal septum.
- H. P. MOSKOW—Harvard Medical School, Bldg B—9 Exhibition of anatomical casts demonstrating the anatomy of the nose and throat. Discussion of teaching methods. Demonstration on the cadaver of the submaxillary approach for deep pus in the neck. P. E. MELTZER and M. H. LURIE. Exhibition of specimens illustrating the anatomy of the ear.
- Staff—Beth Israel Hospital—9 L. M. FREEDMAN. Experiences with vocal cord paralysis in thyroidectomy. D. J. FINE. Technique for relief of bilateral recurrent nerve injury. CHARLES GETTIS. Studies on galvanism in vestibular tests. L. M. FREEDMAN. Jugular puncture in mastoiditis. S. CLINE. Tuberculous laryngitis and its treatment. S. GARDIN. Treatment of malignant tumors of the upper respiratory tract. L. M. FREEDMAN. Bronchoscope studies.
- F. E. GARLAND—Harvard Medical School, Bldg B Demonstration of historical instruments.

WEDNESDAY

- Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases
- WALTER B. HOOVER—New England Deaconess Hospital—9 Operations
- HARRY J. INGLIS and associates—Boston Dispensary—9 Dry clinic. LOUIS WOLKSON. Bronchoscopy in the upright position as an out-patient procedure. A. I. COHEN. F. S. DUREAN and FRANCIS STERN. An improved method of skin testing in allergic disturbances of nose and throat.

- Staff—Children's Hospital—9. LYMAN RICHARDS. Acute laryngo-tracheo bronchitis. MAURICE EVANS. Bilateral jugular ligation and its neurological complications. PHILIP MYERL. Cerebral abscess. CHESTER MILLS. Sinusitis. JOSHUA E. QUINCY. Radical mastoid operation. CHARLES ALLMAN. Unusual foreign bodies. ELMER GILLETTE. Complications in simple mastoidectomy. SAMUEL CLINE. Cases of sinus thrombosis.
- F. G. MINTZER and associates—Carney Hospital—9 Operations and demonstration of cases.
- JOHN BURNS—St. Elizabeth's Hospital—11 Radical sinus operation under nerve block.
- F. E. GARLAND—Harvard Medical School, Bldg B Demonstration of historical instruments.

THURSDAY

- Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases.
- WALTER B. HOOVER—New England Baptist Hospital—9 Operations.
- E. J. BUTLER and C. H. ALLMAN—Cambridge Hospital—9 Operative and dry clinic. Hematogenous infection of left mastoid with extradural abscess in a nine months old child, pneumococcus type III meningitis with labyrinthitis, demonstration of case.
- F. G. MINTZER and associates—Carney Hospital—9 Operations and demonstration of cases.
- C. FAURER—Faulkner Hospital—11 Operations and demonstration of cases.
- WILLIAM T. HALLEY—St. Elizabeth's Hospital—11 Radical operation for maxillary antrum.
- JOHN BURNS—St. Elizabeth's Hospital—11 Radical mastoid operation.
- F. E. GARLAND—Harvard Medical School, Bldg B Demonstration of historical instruments.

FRIDAY

- Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases
- WALTER B. HOOVER—New England Deaconess Hospital—9 Operations.
- F. G. MINTZER and associates—Carney Hospital—9 Operations and demonstration of cases.
- Staff—Massachusetts Eye and Ear Infirmary—9 Dry clinic. H. P. CARILL. The present status of brain abscess from the standpoint of the otologist. P. E. MELTZER. A twelve year summary of cases of lateral sinus thrombosis at the Infirmary. P. MYERL. A ten year review of cases of labyrinthitis at the Infirmary. D. C. SMYTH. Chest cases requiring bronchoscopy, lantern slide demonstration. A. S. MACMILLAN and D. C. SMYTH. The accessory sinuses from the standpoint of the roentgenologist and the clinician. A. S. MACMILLAN. Petrositis from the X-ray standpoint. G. H. POMER. Result of the Mosher Toti tear sac operation. M. H. LURIE. Histological slides showing the pathological condition of the internal ear. E. W. HERMAN. Radium and X-ray treatment of cancer of the larynx. H. P. MOSKOW. Notes on oesophageal cases. F. E. GARLAND. Surgery of the submaxillary gland. C. G. PAGE. Fungi in tracheal and bronchial mucosa. G. L. TOBEY, JR. The Tobey Ayer test.
- F. E. GARLAND—Harvard Medical School, Bldg B Demonstration of historical instruments.

Days to be announced

- ISABELLA D. KEER—New England Hospital for Women and Children—The use of a certain anesthetic in tonsillectomies
- MARGARET NOYES KLEINERT—New England Hospital for Women and Children—Mastoidectomies in infants
- L. F. JOHNSON—Massachusetts Memorial Hospital—Bronchoscopic operative clinic
- C. W. BURT, R. O. PARKER and B. N. WATY—Massachusetts Memorial Hospital—Operations

SURGERY OF THE EYE

MONDAY

- Staff—Massachusetts Eye and Ear Infirmary—2 Operations
- VIRGIN G. CARTER—Massachusetts Eye and Ear Infirmary—3 Visual fields in neurological cases
- T. L. TERRY—Massachusetts Eye and Ear Infirmary—3 Pathological demonstration
- J. H. WAITE and associate—New England Deaconess Hospital—The eye in diabetes
- J. J. REAGAN, SCOTT WATSON and DONALD MITCHELL—Boston City Hospital—3 The eye in arteriosclerosis, hypertension and tumor

TUESDAY

- H. B. C. RUSSELL and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
- DR. BEUZZELL—Massachusetts Eye and Ear Infirmary—9 Technique of photographing the fundus
- F. H. VANDERBILT and assistant—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases
- WILLIAM D. ROWLAND—Massachusetts Memorial Hospital—9 Operations
- EDWARD D. HURLEY and associates—Carney Hospital—9 Operations and demonstration of cases
- PETER McADAMS—St. Elizabeth's Hospital—Operations
- J. H. WAITE and associate—New England Deaconess Hospital—3 The eye in thyroid
- A. G. CARTER—Long Island Hospital—3 Operations

WEDNESDAY

- J. HERBERT WAITE and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
- DR. BEUZZELL—Massachusetts Eye and Ear Infirmary—9 Technique of photographing the fundus
- F. H. VANDERBILT and assistant—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases
- Staff—Boston Dispensary—9 The eye and syphilis
- EDWARD D. HURLEY and associates—Carney Hospital—9 Operations and demonstration of cases

- H. L. BASCOCK—Massachusetts Memorial Hospital—Otolaryngological problems in contagious diseases
- A. W. ROWE and D. W. DUNN—Massachusetts Memorial Hospital—Endocrine factors in deafness
- OLIVER A. LOTTISON—Newton Hospital—Tonsil, sinus and septum operations—reduction of recent fractures of the maxilla and nasal bones, discussion of the indications for mastoid and sinus surgery
- CHARLES I. JOHNSON, DONALD H. McDONALD and EDGAR M. HOLMES—Newton Hospital—Operations and demonstration of cases

- HUGH DONAHUE—St. Elizabeth's Hospital—1 Operation for cataract
- WILEY GREENWOOD—Massachusetts Eye and Ear Infirmary—1 Fundus cases
- T. L. TERRY—Massachusetts Eye and Ear Infirmary—1 Pathological demonstration
- Staff—Massachusetts Eye and Ear Infirmary—3 Operations, motion pictures

THURSDAY

- EDWARD K. FILLES and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
- H. B. C. RUSSELL—Massachusetts Eye and Ear Infirmary—9 External diseases of the eye
- EDWARD D. HURLEY and associates—Carney Hospital—9 Operations and demonstration of cases
- DRS. LIEBERMAN and SACHS—Beth Israel Hospital—10. Cataract extraction, muscle advancement, demonstration of cases
- J. J. DUNN—Massachusetts Eye and Ear Infirmary—3 Traumatic injuries, methods of treatment and results
- Staff—Massachusetts Memorial Hospital—3 Operations and demonstration of cases
- J. J. REAGAN and DONALD MITCHELL—Boston City Hospital—3 Neurological cases, dry chink

FRIDAY

- W. HOLMES, LOWELL and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
- DR. McCARTHY—Massachusetts Eye and Ear Infirmary—9 Color vision testing
- J. J. REAGAN and staff—Boston City Hospital—9 Operations
- EDWARD D. HURLEY and associates—Carney Hospital—9 Operations and demonstration of cases
- VIRGIN G. CARTER—Massachusetts Eye and Ear Infirmary—9 Ocular paralysis in neurological cases
- T. L. TERRY—Massachusetts Eye and Ear Infirmary—3 Pathological demonstration
- Staff—Massachusetts Eye and Ear Infirmary—3 Operations
- J. J. REAGAN and WILLIAM B. CASTLE—Boston City Hospital—3 The eye in anuric patients

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THE BEHAVIOR OF TRANSPLANTED BONE

A CLINICAL CONSIDERATION¹

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IT is the purpose of this paper to discuss briefly the theories and facts regarding the behavior of various types of bone grafts, to suggest that certain ideas which have seemed contradictory are reconcilable. Clinical evidence of the latter is presented together with a short consideration of the technique of bone grafting.

Successful results following the transplantation of living tissue have been well established. Better and simpler methods for handling such tissues are even now being perfected. The future promises much. This is especially true in the field of reconstructive bone surgery. Ollier first gave definite evidence upon which much of our present day technique is based. The rôle which the periosteum plays in bone formation was carefully worked out by him and today stands, disputed but not disproved. His belief that homogeneous periosteal transplants do regenerate bone is upheld by Axhausen, Lexer, Mayer and Wehner. Mock and others. On the other side of the question stand Macewen, Dorrance, Ely and others. It is their contention that pure periosteal transplants do not regenerate bone, and that when seemingly successful results have been obtained it has been because bits of cortex and cambium layer have been removed with the periosteum. Be that as it may, it is of practical importance to know that we can expect bone regeneration following subperiosteal re-

section and transplantation of periosteum removed under aseptic conditions with careful technique.

Since Ollier's report, much work has been done on bone growth. It is not the purpose of this paper to review this work in its entirety. It will suffice to mention, briefly, work pertinent to the question of bone transplantation including in this category the various types of bone grafts.

The circulation is a very important factor. Johnson, by his thorough investigation, has shown what part is played by each of the three nutrient systems of the long bones. His conclusions are that the nutrient vessels which supply the medulla and inner half of the cortex enhance active repair in the absence of the two other systems. The metaphyseal system supplying the same areas affords slower, but complete repair in the absence of the two other systems. This is noticeably marked at the mid shaft. The periosteal system nourishing the periosteum and outer half of the cortex does not establish a collateral supply in the medulla under 4 weeks and in the absence of the two other systems produces poor healing of cortical defects. Regarding the shaft as a whole, bone regeneration depends upon a blood supply from the systems in the order mentioned.

Axhausen reports several cases of ischemic bone necrosis and throws considerable doubt

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on the teaching that bone is not susceptible to infarction. Morton and Stabins have shown that a partial block in the veins of an extremity in which there is a fracture seems to cause delayed union. They found this also held true for resection. Pollock, Blaisdell and McKenney state that a bone graft will live only if it is quickly surrounded by well vascularized connective tissue. Bancroft also believes that a successful graft depends upon the ease with which a blood supply is established. We can scarcely overlook the fact that success or failure in plastic bone surgery depends upon a good blood supply to both bone and soft tissue surrounding bone. It would also seem that rupture of the nutrient artery did not necessarily mean failure of union.

Next it is well to consider the various bone elements and their functions in bone regeneration. Haas has shown that the increase in bone length is entirely dependent on the multiplication of cartilage cells of the epiphyseal cartilage plate and is not aided by interstitial proliferation and also that the increase in thickness is due to deposition of new bone from periosteum.

The rôle of the periosteum has been discussed but in addition to the question of its power to regenerate bone *per se* this covering has other functions. Mock believes that the periosteum together with the endosteum, contains the chief factors for osteogenesis. Ely has shown that osseous union is good provided the periosteum is intact that with complete division of the periosteum, non-union results and that if the periosteum is slit longitudinally in several places there may or may not be union. From this he concludes that the periosteum probably protects the enclosed hemorrhage and granulation tissue that it has no bone forming function and that bone is not built out of it. Mock has demonstrated that the more completely surrounded the site of fracture by periosteum the quicker and stronger the union.

The cambium layer is of striking importance as bone regeneration usually takes place in its presence. This has been well pointed out by Mayer and Wehner, Brooks, Phemister, Thalhimer and Haldeman. This is found to be

true whether it is attached to periosteal or cortical transplants.

Can transplanted cortex be expected to regenerate bone, and if so must it be living tissue? In either case it furnishes a good internal splint. Lexer found that living bone was preferable to dead bone. He states that he has never failed to gain a successful transplant if the transplanted living bone was attached to its periosteum. Haas, Ely, Sutton and Pollock have shown that transplanted boiled bone does not live or stimulate new bone formation. Mayer and Wehner have been able to secure new bone production from periosteal free transplants but they believe that it was owing to the fact that the cambium could not be stripped from the cortex nor could the osteoblasts be removed from the marrow or the haversian canals. Bancroft, Ely and Janeway are of the opinion that all grafts die and act only as a framework upon which new bone is formed. It is impossible at present to conclude definitely whether or not living cortex produces new bone. We do have evidence that the endosteal cells lining the haversian canals have some function in bone formation. This was pointed out by Brooks and has been mentioned.

The reports of Johnson, Brooks, Mayer and Wehner, Mock, Ely and Campbell lead to the conclusion that endosteum forms callus. We have been unable to find any experimental evidence pointing to regeneration of bone from transplanted endosteum alone.

Marrow does play some part in contributing endosteal cells for bone production. McGaw and Harbin have just finished a series of transplants of bone marrow in dogs. They found that extraperiosteal defects, produced surgically in the fibula, are completely bridged by bone following the transplantation of coretings from the marrow cavity of the tibia. Most workers advise using an entire bone segment for inlay grafts, including marrow. Lexer finds it advantageous to remove it in the transplantation of complete segments of tubular bone.

The question of whether or not a bone graft lives is still much debated. There are good arguments on each side. Lælen, Frankenstein, Pakopilo, Lobenhoffer, Lexer and Axhausen

hold that the bony part of the transplant becomes absorbed, the periosteum survives and lays down new bone. Baschkirzew and Petrow, on the basis of animal experimentation and clinical cases, conclude that it is not necessary to include periosteum in the transplant in order to obtain new bone. Mayer and Wehner state that the already mature bone cells do not show proliferation. Axhausen, Brooks, Haas, Plemister and Thalheimer maintain that a free bone transplant is a source of regeneration of bone and not merely a skeleton upon which bone is formed.

Bancroft holds that transplants *per se* do not live but act as a framework and help to establish "a favorable chemical state." Ellis and Janeway are also of this opinion.

And so we may look to either side of many questions. From a surgical standpoint it has been amply demonstrated that bone defects can be repaired by transplanting or grafting periosteum, osteum and periosteum, osteum and endosteum, complete sections to include all layers, complete bone segments and even entire joints. With this we can proceed to a consideration of types of grafts and indications for their use believing that the cases to be reported indicate that homotransplants of any of the bone elements live as such. Further, it is our feeling that much evidence regarding the behavior of bone transplants which has seemed contradictory is consistent. This statement is based upon our impression that there are several ways in which bone may be have and that the reparative process may not always be the same.

It is our opinion that metal plates should be discarded in favor of living bone grafts in all fractures in which solution of continuity can not be maintained without the aid of an internal splint. We will consider the full thickness inlay, the cortical onlay, the osteoperiosteal, the medullary, the sliding and the massive transplant grafts (Fig. 1).

The first two are probably of equal value. Both contain all bone elements and provide adequate internal splinting. The onlay graft has the advantage of incorporating only living tissues in the repair as the graft is secured with autogenous bone pegs. The inlay graft

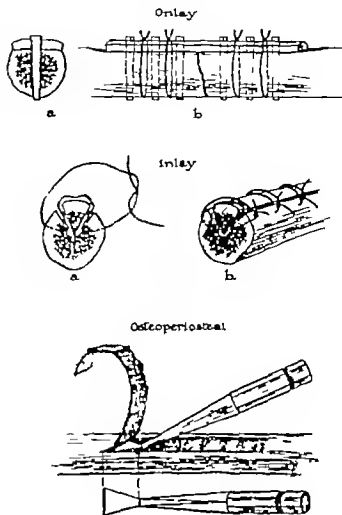


Fig. 1. Technique of three types of bone grafts.

affords a stronger splint but requires careful fitting and should be secured into a carefully prepared bed with braided silk ligatures.

The osteoperiosteal graft may be used in fractures not requiring an internal splint. We report its use as a method to increase the thickness of transplanted bone.

The medullary graft is to be condemned as it is in direct opposition to normal bone physiology and its use more often results in failure than in success.

The sliding graft is good and can always be used in fractures in which sufficient bone length is present to permit a graft of adequate length to be cut. It is valuable because only one operative field is necessary. It avoids the danger of cross contamination.

Massive transplants are of value in replacing bone which has been resected. The procedure is usually carried out in two stages in



Fig 2

Fig 3

Fig 4

Fig 5

- Fig 2 Case: Pre-operative film showing eburnation at the ends of the fragments.
 Fig 3 Case: Film taken 7 months following transplantation of the intramedullary graft and 8 weeks following its fracture. Partial absorption of the graft and marked atrophy of the fragments is well shown.
 Fig 4 Case: Three months following transplantation of the relay graft. The graft appears stable. There is good callus formation.
 Fig 5 Case: Five months following transplantation of the relay graft. The defect has been completely bridged by bone. There is no evidence of absorption of the graft.

an effort to maintain at all times an adequate blood supply for the transplanted fragment.

The material in the following protocols covers each type of graft. It is also of interest because it shows something of the behavior of transplanted bone even in the presence of infection.

PROTOCOLS

CASE 1. A white male, 57 years old, was admitted to the Lakeside Hospital July 5, 1932, with an ununited fracture at the junction of the upper and middle thirds of the right humerus. The fracture had been sustained in December, 1931. Closed reduction was carried out in another hospital. Union did not take place, and an open reduction was done at the same hospital in March, 1932. At that time about 3.5 centimeters of bone was resected. After 4 months there was no union.

The past and family history were unimportant. The patient was well developed and nourished. The general physical examination was not important. The right arm showed moderate atrophy but sensation was intact. There was 3 centimeters shortening. The ends of the two fragments were

palpable and a false joint was present. The examination of the blood and urine was normal. The Wassermann reaction was negative. The blood calcium was 11.0 milligrams per cent. X-ray films showed an ununited fracture with no callus formation and separation of 1 centimeter (Fig. 2).

On July 6, 1932, an open reduction was carried out. The incision made over the inner border of the deltoid muscle, was carried down to the bone. The ends of the exposed fragments were covered with a cartilaginous cap and were densely eburnated. Surrounding the false joint was a membranous sac similar to synovium, filled with fluid. The ends of the fragments were freshened and the medullary cavity entered. A full thickness graft 9 by 1.5 centimeters was removed from the tibia and placed within the medullary canal. No sutures were placed. The muscles and skin were then closed in two layers. The arm was immobilized in a plaster shoulder spica. X-ray films showed the fragments to be in good condition. The wounds healed *per primam* and the patient was discharged on the thirteenth postoperative day.

The spica was removed after 4 months and physical therapy was started. X-ray films showed only slight callus formation and some absorption of the



Fig 6

Fig 6 Case 2. Film taken before operation. It shows sclerosis of the ends of the fragments and marked angulation. Fibrous union is present.



Fig 7

Fig 7 Case 2. Film of tibia and fibula 4 years following graft. This shows quite well the position of the autogenous bone pegs.

Fig 8

Fig 8 Case 2. Film of tibia and fibula 4 years following graft. This shows quite well the position of the autogenous bone pegs.

graft. Two weeks later, under minimal strain the graft fractured (Fig 3). On the second admission in February, 1933, roentgenograms showed complete absorption of the graft, marked atrophy of the fragments, and complete separation. The laboratory findings were not remarkable.

On February 24, 1933, an open reduction was carried out. The incision was carried down through the anterior portion of the deltoid muscle and the bone exposed. A false joint was encountered. The fibrous tissue covering the ends of the fragments was cut away. The periosteum was stripped from the anterior surface of both fragments. The medullary canal was entered with a drill. None of the previous graft remained. No sequestrum was found. A V-shaped, full thickness graft, 15 by 2 centimeters, was removed from the tibia and securely fastened into a previously prepared bed with overlapping horizontal silk ligatures. The periosteum, muscles and fascia were closed in two layers. The skin was closed with silk. The arm was immobilized in a plaster shoulder spica. The wounds healed and the patient was discharged after 24 days.

On May 11, 1933, X-ray films suggested that the graft was viable (Fig 4). Callus formation was present.

On July 18, 1933, X-ray examination showed complete union (Fig 5). Clinically union was solid. Function was good.

CASE 2. A girl, 11 years old, white, entered the Lakeside Hospital in November, 1927, with a marked

deformity of the left leg. Six years previously, in Canada, a metal plate had been applied to the left tibia following fracture. The bone became infected. Several operative procedures followed in an effort to institute drainage and also to straighten the resulting deformity. The osteomyelitis was arrested but the deformity was never overcome. The family history was not remarkable except for the left lower extremity. There was marked anterior and lateral angulation of the tibia and fibula, with only fibrous union of the tibia (Fig 6). The anterior angulation measured 120 degrees. There was a 2 centimeter atrophy of the thigh and 5 centimeters shortening of the leg. There were no sensory or motor changes. Numerous scars were present over the leg. The laboratory findings were entirely normal.

On November 15, 1927, a wedge osteotomy and lengthening of the tendo achillis was carried out. The ends of the fragments were secured with braided silk ligatures. The periosteum was closed over the site of apposition and the soft tissues approximated in the usual manner. The leg was immobilized in plaster. X-rays showed satisfactory position, no angulation, but marked sclerosis of the bone. The wound healed and the patient was discharged on the thirty-ninth postoperative day.

Union failed and the patient again entered the Lakeside Hospital in July, 1928. On September 15, 1928, an onlay graft, 13 by 2 centimeters, was removed from the right tibia and secured over the site of fracture with six autogenous bone pegs. A piece of

medullary bone was also placed in the medullary canal (According to the method described by Campbell and Henderson). The leg was immobilized in plaster. At operation the left tibia was found to be atrophic. There was no callus. Fibrous union existed. X-ray films showed good position following operation (Fig 7). The wounds healed and the child was discharged after 9 days.

On May 21 1930, this child fell and fractured the right tibia. She was again brought to the Lakeside Hospital. This fracture was reduced and the child was again discharged. At this time there was both clinical and X-ray evidence of good union in the left tibia.

On June 28 1932 X-ray examination showed both fractures completely united (Fig 8). Function in both legs was normal. There was shortening of 2 centimeters in the left leg.

CASE 3. A 19 year old white female entered the Lakeside Hospital on April 22 1931 with a fall right arm. In 1924 she had injured the right arm and the bone had become infected. The upper portion of the humerus was resected. (This treatment had been carried out in Vienna and we did not obtain information concerning the details). The past history and the family history were unimportant.

On examination the findings of interest were limited to the right upper extremity. There was considerable atrophy of the part. Several linear surgical scars were present. The shoulder joint was dull. The upper end of the humerus could be palpated 4.5 centimeters below the shoulder. The urine and blood studies were normal. X-ray examination showed the humerus to end in a tapered point (Fig 9). The entire bone was reduced in circumference and flattened in the anteroposterior diameter. The bone was sclerotic.

On April 24 1931 the upper 11 centimeters of the right fibula was transplanted. Scar tissue was removed from the upper 11 centimeters of the humerus and the proximal 2.5 centimeters of the bone was removed. The posterior portion of the bone was removed for a distance of 3 centimeters exposing the medullary canal. Compact bone was then cut from the distal 8 centimeters of the fibular transplant. The head was placed in the glenoid cavity and secured by suturing the scar tissue around it. The freshened bone surfaces were approximated and secured by braided silk sutures threaded through perforations. Care was taken to approximate the periosteum. Soft tissue closure was carried out after the usual fashion. The arm was immobilized in a spica in 40 degrees abduction. X-ray films showed the position to be excellent (Fig 10). The patient was discharged on the twenty first postoperative day with the wound healed.

Firm union resulted and she obtained a fair degree of function. In March, 1932 while frolicing and using this arm, the patient fractured the right humerus but she did not report to our clinic until April 5, 1932. At this time X-ray examination showed a comminuted fracture through the transplanted fibula about 4

centimeters from its insertion into the humerus (Fig 11). The arm was immobilized. Nothing further was done as we wished to observe whether callus formation or absorption would follow. She again entered the hospital on May 20, 1932. The X-ray showed absorption and no callus formation. On May 31 1932 two osteoperiosteal grafts were removed from the left tibia and secured over the site of fracture with No. 0 chromic catgut sutures tied around the bone. Several small bone chips were also placed between the ends of the fragments. The arm was immobilized in a plaster spica abducted 35 degrees.

At operation as soon as the periosteum over the transplanted fibula was incised and elevated, there was considerable oozing suggesting it to be well vascularized. Bleeding took place from the ends of the fragments as well. Following this procedure X-ray examination showed good alignment. On July 5 1932 there was good callus formation but no union. The patient was discharged on the sixty third post operative day. On May 11 1933 roentgenograms showed good union (Fig 12). The patient was using the arm and the total range of motion was 50 per cent of normal.

CASE 4. A white male, aged 43 years, entered the Lakeside Hospital on January 6, 1933 with an ununited fracture of the left tibia. In September 1931 he sustained a compound fracture of both bones in both lower extremities. Closed reduction resulted in union however there was overlapping of the fragments in the left leg. The bones were surgically fractured and reset. Non-union resulted.

The past and family history were not important. The general physical examination was not of note. The left leg was 3 centimeters longer than the right with some atrophy of the calf and thigh. False motion was present. The lower fragment was posterior. Laboratory findings were normal. X-ray films revealed that there was an oblique fracture at the junction of the middle and lower thirds of the tibia with considerable callus about the proximal fragment (Fig 13). Also, there was a comminuted fracture of the fibula.

On January 7 1933 an operation utilizing a sliding bone graft was carried out. Fibrous union was present. Excess callus and fibrous tissue were removed with an osteotome. The lower fragment was eburnated. Multiple drill holes were made into the medullary cavities of both fragments. A sliding graft 13 by 2 centimeters, was cut from the upper fragment. A corresponding portion of bone was removed from the lower fragment. The graft was secured with overlapping braided silk sutures passed through perforations. The periosteum was approximated and the soft tissues were closed. The entire leg was immobilized in plaster. X-rays on January 12 1933 showed some posterior bowing. Another cast was applied. It was necessary to wedge the cast in order to secure good alignment (Fig 14). The patient was discharged on the fifteenth day after operation with the wound well healed.

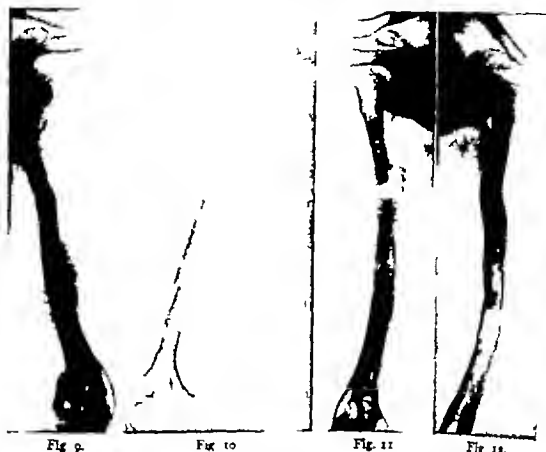


Fig. 9. Case 3. Pre-operative film showing absence of proximal portion of the femur, marked sclerosis and decrease in the thickness of the remaining bone.

Fig. 10. Case 3. Film showing transplanted fibula in position.

Fig. 11. Case 3. One year following transplantation of the fibula and 1 month following fracture of the graft. The proximal fragment has the appearance of normal bone. The distal portion of the transplanted fibula appears to have established complete continuity with the femur.

Fig. 12. Case 3. One year following the application of two osteoperiosteal grafts.

On March 29, 1933, X-ray films showed good position, with definite callus formation. Clinically there was union.

The patient returned to the clinic 3 weeks later. Against our advice, he had removed the cast at home. Examination of the extremity showed the callus to be soft. X-ray showed beginning absorption of the callus across the fracture line. The leg was again immobilized in plaster. The last examination on September 20, 1933, showed the callus to be firm and non-tender. The X-rays revealed bone formation at the site of the graft, but none where the fragments were simply in apposition (Fig. 13).

CASE 5. A 14-year-old white female entered the Lakeside Hospital on July 11, 1932, with chronic osteomyelitis of the right tibia of 2 years' duration. Incision and drainage were carried out on several occasions but there was no improvement.

The child had had frequent infections of the ears and throat. One brother had tuberculosis. The patient was well developed and nourished. The general physical examination was unimportant. Several scars were present over the right tibia. There were no discharging sinuses. There was no atrophy

or shortening. Joint motion was normal. The heart and urine were normal. X-ray films showed evidence of chronic osteomyelitis.

Over a period of 1 year, multiple incisions for drainage of the infection were carried out. At the end of a year all drainage had ceased and the patient was discharged.

On November 5, 1934, she again entered the hospital with a discharging sinus extending to the middle third of the tibia. X-ray films showed involvement of the entire shaft of the tibia. A segmental resection of the entire shaft of the tibia was performed. The periosteum was sutured over the ends of the bone and the leg was immobilized. After a course of treatment all evidence of osteomyelitis disappeared. The X-rays showed no bone reaction. The patient was discharged wearing a cast.

She next entered the Lakeside Hospital on March 14, 1935, for transplantation of the fibula. X-ray films showed no bone reaction at the fibula. There had been no drainage for about a year and a half. The lower end of the fibula was secured to the tibia. The lower tibial stump was secured to the fibula. The proximal end of the fibula was secured to the tibia. The usual



Fig. 3

Fig. 14

Fig. 15

Fig. 3 Case 4. Pre operative film showing non-union of tibia and fibula.

Fig. 14 Case 4. Film 7 days following sliding bone graft.

Fig. 5 Case 4. Film 7 months postoperative and 8

weeks following application of the second plaster splint. Anteriorly trabeculations of bone can be traced across the fracture line. Posteriorly away from the graft, there is no evidence of this.

was carried out. The leg was immobilized in plaster. X rays 2 months later showed firm union.

She returned September 22, 1925 for transplantation of the upper end of the fibula. This was done. The periosteum was closed over the junction. A plaster splint was again applied.

Two months later there was no evidence by X ray examination of bone regeneration. A reimplantation was done. At operation there was found no evidence of osteogenesis. Both fragments showed marked atrophy. A new bed was prepared in the stump of the tibia and two chromic catgut sutures were used to anchor the fibula into this groove. Periosteum again covered the site of transplantation. The leg was immobilized with plaster. The patient was discharged 3 months later. X ray examination showed good union of the lower fragments but no evidence of bone regeneration at the site of the recent transplant. Alinement was good. X ray examination 4 months later showed only slight callus formation. Clinically there was non-union. The patient was able to walk in a brace, however.

She was followed for 5 years. Subsequent X ray films showed complete union of the graft to the tibial stump. However the transplanted fibula was inadequate for weight bearing and it was necessary for her to wear a brace continuously. She was somewhat overweight (Fig. 16).

The next admission to the Lakeside Hospital was on November 11, 1930, at which time two osteoperiosteal grafts, 9 by 1 centimeters were removed from the left tibia and placed on the lateral and medial cortical surfaces of the right fibula which had been freshened with an osteotome (Fig. 17). These grafts were secured by multiple No. 6 chromic catgut sutures. The periosteal edges were approximated with the same material. The right leg was immobilized in plaster. The wounds closed by first intention and the patient was discharged on the twenty-eighth postoperative day.

A brace was soon applied and the patient's condition was good until February 19, 1931, when she was readmitted for incision and drainage of a soft tissue abscess over the lower, lateral aspect of the right leg. Repeated X-ray examinations showed no evidence of osteomyelitis. They did reveal increase in thickness of the transplant. The wound healed and the patient was discharged.

Röntgenograms taken September 11, 1931, showed that there was definite proliferation around the transplanted fibula.

She began to walk without a brace in August, 1932, and has continued to walk without support. X ray films on March 29, 1933, showed considerable increase in circumference of the transplanted fibula (Fig. 18).



Fig 16

Fig 17

Fig 18.

Fig 16 Case 5. Film 5 years following transplantation of the fibula. Hypertrophy has failed to take place.

Fig 17 Case 5. Postoperative film showing the osteoperoneal graft in position. This gives a very good conception of "shaving like" quality of freshly removed graft.

Fig 18 Case 5. Film one and one-half years following the application of the osteoperoneal graft. This roentgenogram shows that there is thickening of the cortex and considerable increase in the circumference of the transplanted fibula.

CASE 6. A white female, 6 $\frac{3}{4}$ years of age, was admitted to the Lakeside Hospital September 18, 1929, with acute osteomyelitis of the left tibia which developed following trauma to the dorsum of the left foot. Five weeks before she had cellulitis of a finger subsequent to a puncture wound. This infection subsided under treatment.

The acute osteomyelitis had been treated in another hospital. Following incision and drainage she was transferred to the Lakeside Hospital. The family history and the past history were unimportant. Examination showed an acutely ill, quite pallid child. The heart revealed a mitral stenosis with insufficiency. The left inguinal nodes were enlarged and palpable. Pus exuded from four incisions over the lower tibia. Swelling, redness, and bone tenderness were present. The urine was normal, the white

blood count was 12,000, red blood count 3,400,000, hemoglobin 65 per cent. X-ray films showed definite evidence of osteomyelitis of the left tibia. Subsequent incision and drainage was carried out with no improvement. X-ray examination showed progressive bone destruction. Resection of the tibia was advised and executed.

Both ends of the exposed tibia were almost devoid of attachment. The entire shaft was removed and the periosteum remaining was sutured to form a gutter. Dakin's tubes were inserted. The leg was immobilized in a Cabot splint. A plaster splint was applied on the twenty-third postoperative day and the patient was discharged 15 days later at which time the wound was largely healed. X-ray films taken at that time showed no evidence of bone regeneration.



Fig. 9. Left. Case 6. Seven months following transplantation of the lower end of the fibula into the stump of the tibia.

Fig. 10. Case 6. Film 30 months following transplantation of the upper end of the fibula.

The wound healed completely but there was only slight regeneration of bone. There had been no evidence of osteomyelitis for 18 months prior to April 4, 1931, when the child again entered the Lakeside Hospital for transplantation of the fibula. The lower end of the fibula was transplanted into a groove made in the distal stump of the tibia and the periosteum approximated with No. 6 chromic catgut sutures. The leg was immobilized in plaster. X-ray examination showed good position.

The wound became infected and drained for 4 weeks. Roentgenograms 4 weeks after transplant showed proliferation of the periosteum over the lower fibula and no evidence of osteomyelitis. The child was discharged.

Several weeks later drainage appeared. Because of persistent drainage and X-ray evidence of bone destruction a sequestrectomy was carried out on July 15, 1931. After removal of the sequestrum about 2 centimeters of the distal fibula remained attached to the lower tibial fragment.

Maggots were then implanted on three occasions, at five day intervals. A plaster splint was applied and the child was discharged. Slight drainage was

still present. After 6 weeks of convalescence, all drainage ceased.

On November 21, 1931, X-ray films showed excellent union of the bone and no evidence of osteomyelitis (Fig. 10). On January 4, 1932, a subperiosteal transplantation of the upper end of the fibula was carried out. The fibula was divided just below the epiphyseal line and secured, with a No. 1 chromic catgut tie, into a linear groove cut in the tibial stump. The periosteum was approximated and the wound closed. The leg was encased in a plaster splint.

This wound again became infected and it was necessary to incise and remove a few small sequestra. Maggots were again implanted on three occasions. The leg was immobilized. Drainage gradually subsided. X-ray films on March 22, 1932, showed a definite bridge of bone extending from the upper fibular stump to the transplanted fibula but no bone regeneration at the site of the transplant. The child was discharged in December, 1932. She was then walking in a caliper splint.

On March 30, 1933, the child was walking without support. There was 4 centimeters shortening of the left leg. Function was good. X-ray picture taken on September 1, 1933, showed good union and satisfactory hypertrophy of the transplanted fibula (Fig. 10).

These cases have been selected because they illustrate several factors concerning the behavior of bone repair and regeneration. Case 5 represents a method of utilizing an osteoperiosteal graft to increase the volume of bone. No attempt is made to draw unqualified conclusions from so few cases.

It is our feeling that a large percentage of homotransplants live as such. Case 3 furnishes several examples. At the end of a year the transplanted bone was completely revascularized. Bone atrophy took place in the absence of function as normal bone does and bone regeneration was again stimulated by the introduction of transplanted bone. In the last 2 cases it is our opinion that massive transplants do not die in entirety; that in the absence of infection union usually takes place early. This entails osteoclysis and osteoclysis at the site of union but no change in the shaft. The much disputed question as to whether or not every cell of transplanted bone dies and is replaced need not be disturbing. It may well be true that a degree of creeping substitution takes place. That piece of bone lives if we can consider growth and revascularization any indication of life. We do not know the exact mechanism of this rehabilitation nor

have we found any evidence in the literature which would lead us to an unquestionable answer. When bone is transplanted according to proper technique, we expect growth in 90 per cent of all cases. In the absence of infection and disturbance in circulation this should approach 99 per cent, provided the transplant is properly carried out and immobilization maintained over a sufficient period of time.

Infection does not mean absolute failure. In our last reported case infection complicated each procedure, yet this child eventually secured good union. We must, however, expect delay and in some cases failure.

In order to emphasize the inadvisability of using the intramedullary graft we again refer to Case 1. In this instance it is also interesting to note that the transplant was completely absorbed in 7 months. This is often the fate of such a graft. Also when the graft "takes" it frequently results in a painful member.

Case 2 is of considerable interest. After osteotomy with good reduction the sclerotic bone failed to unite. After application of an onlay graft union was solid. We must conclude that the graft had much to do with the production of new bone as no other factor had been altered.

Case 3 also offers an example of the type of fracture in which an osteoperiosteal graft is sufficient to bring about firm union. In support of our original statement, we find it hard to explain solid union within 5 months had the transplanted fibula not been living bone.

The fourth case brings up a question of some practical importance, namely, should a fracture undergoing repair be subjected to major trauma. Clinically there was union after 8 weeks. At this time the bones were re-fractured. Non union resulted. Such a result is observed in fractures not sufficiently immobilized. The physiological process must be similar. It would seem that in such a case intervention should be very early. After 2 months it would probably be wiser to wait for a period of 1 year before attempting closed re-fracture and reduction. The case also demonstrates the efficacy of a sliding bone graft. It

also demonstrates the necessity of an adequate period of immobilization.

Case 5 demonstrates the ability of an osteoperiosteal graft to stimulate bone production. It was obvious that even after a period of 5 years the transplanted tibia was not of sufficient diameter and strength to bear the weight of a girl weighing 150 pounds. The osteoperiosteal grafts were applied directly over the shaft of the transplanted fibula. New bone was formed and became a part of the fibula. Today the strength of the bone is adequate. The girl is walking without support and her weight is in the neighborhood of 150 pounds.

The last case recalls once again the hazard of bone surgery in cases of arrested osteomyelitis. Bacteria hid away in well protected lacunae. The child lived for years. Once these abscesses appeared they grew with renewed virulence. Such a complication is difficult to avoid but one should not be surprised should it occur. Most implantations were used unilaterally and in children in infected ununited fractures with resultant union. It is our impression that the maggots or their by-products inhibit osteogenesis. It is also of some interest to note that even before there was union of the tibia to the upper tibial stump, ossification had taken place from the upper epiphyseal line of the fibular stump and that this bone was firmly united to the transplanted tibia. This took place even in the presence of infection.

We do not advocate radical resection for osteomyelitis. The results of fibular transplantation in the few cases which we have had to do offers hope in those individuals who may be so unfortunate as to have been subjected to such a radical procedure.

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A METHOD FOR DETERMINING THE TIME OF CATGUT DIGESTION *IN VITRO*¹

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AT a recent symposium conducted by the New York Surgical Society (5) the frequency of wound disruption with its high mortality was emphasized by representatives of five of the larger hospitals of this city. All of the various factors which interfere with normal wound healing were discussed. We were particularly impressed with one significant fact brought out by several of the authors who pointed out that often no trace, or very little trace of the chromic catgut suture material could be found at any of the secondary operative closures. These were usually performed on the day of disruption and occurred from 3 to 15 days after the primary procedure.

In a certain number of cases pancreatic biliary, or gastric discharge might have been responsible for the premature digestion. In another group of cases infection may have played an important rôle. This relationship between infection and rapid catgut absorption has frequently been observed clinically and certain experimental observations have been made which seem to demonstrate its importance (2).

The majority of disruptions occur however, in cases in which infection is not a prominent feature. These can be explained only on the basis that the sutures do not maintain the approximation of the tissues until healing has been adequate to withstand the tension caused by intra abdominal pressure or general body movements. This fact emphasizes the importance of obtaining a better knowledge of catgut digestion within the body. Howes has studied this problem and has attempted to measure the rate of wound healing in various animal tissues (4). He has recently compared the strength of wounds sutured with catgut and silk in the rat's stomach (3) and has found that the wounds sutured with silk are consistently stronger and healing takes place with greater speed than in those sutured with catgut.

Porta was among the first (1845) to observe the absorption of various suture materials in animals. He noted considerable variation in the absorption time of catgut. Lister suggested sterilizing catgut with carbolic acid and prolonging its absorption time by chromicizing. Many others have studied the absorption of catgut *in vivo* with considerable variation in the results (1). This is readily understood when one considers the factors which operate under these experimental conditions. There are individual variations in the animals which are used. The position of the suture in the tissue, and the tension under which it is placed, are both difficult to control and no two investigators have adopted exactly the same method. Other important factors which have been shown to influence the absorption of catgut (2) are obviously uncontrollable—namely the blood supply of the tissue, the degree of exudation and bleeding about the suture when it is inserted, as well as the factor of bacterial contamination which occurs even in apparently clean wounds made with the usual aseptic precautions. With such variable factors in animal experimentation it seems almost impossible to standardize the absorbability of catgut by those methods, and we know of no other generally accepted method which lends itself readily to standardization.

At present we are guided to a large extent by the statements made by the various catgut manufacturers regarding the absorption time of their product in human tissues. Some of these firms attempt to judge this time by the results of animal experiments. Others periodically test their products for loss of tensile strength after contact with proteolytic enzymes in test tubes. Still others assume that by chromicizing catgut in a certain way for a certain length of time it will satisfactorily withstand absorption for a sufficient time to permit wound healing. Some catgut firms state that their product will hold the tissues for 10, 20, or 40 days. Others claim that their

¹From the Bacteriological Research Laboratory of the Surgical Department of the College of Physicians and Surgeons, Columbia University and the Presbyterian Hospital, New York.

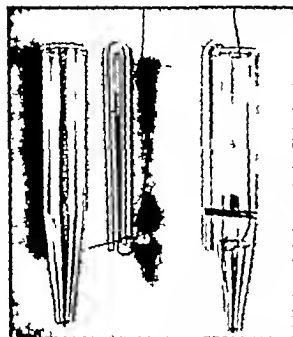


Fig. 1. Method of attaching catgut to glass rod by a slip knot. At the right, the rod has been fastened to the centrifuge tube by an elastic band.

catgut will resist complete absorption for that length of time which is quite a different thing. Others only go so far as to state that their product is hard, medium or soft. In other words,

there is no standardized test for catgut absorption and the frequency of disruption of wounds sutured with catgut indicates that it is a matter of considerable importance.

During the last three years a committee of the American Medical Association has tried to get the catgut manufacturers to agree upon a standard test for catgut absorbability but the manufacturers have apparently been unable to come to an agreement. Obviously this must be a test tube laboratory determination in order that it may be applied periodically under controlled conditions to a large number of specimens and in order to prove its worth an attempt must be made to correlate such a test with certain observations of absorption in human tissues or in animal tissues. It is with these things in mind that we offer this preliminary report of a method which is accurately controlled and will be adaptable to standardization.

This method consists of subjecting a strand of the catgut to the digesting action of a standard trypsin solution. This is prepared by adding 2 per cent by weight of trypsin powder to a buffer solution of primary potassium phosphate and secondary sodium

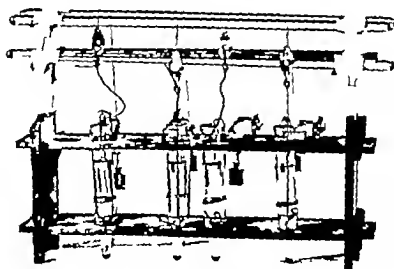


Fig. 2. Front view of the special test tube rack.

phosphate at a hydrogen ion concentration of 8. The same brand of trypsin should be used consistently as there is some variation in the efficiency of the various commercial products.¹ A slip knot is made on the end of a strand of the catgut and this is placed over the shank of a glass rod (Fig. 1). This is done rather than tying a simple knot which fractures some of the fibers particularly if the gut is brittle. The glass rod and the attached catgut are then inserted into a centrifuge tube containing 10 cubic centimeters of the digesting media. This allows 4 centimeters of the catgut to be exposed to the media. A rubber band is used to hold the glass rod to the centrifuge tube. This is placed in a special test tube rack (Fig. 2) and the free end of the catgut is attached to a clip so that contact is made at a switch on the opposite side of the test tube rack (Fig. 3 shows the switch mechanism with two strands broken and two unbroken, making contact). A diagram of the mechanism is shown in side view in Figure 4. A 20 gram weight is attached to the opposite side of the switch to exert constant tension. The entire apparatus is set up

¹Difco trypsin was used in all of our experiments.

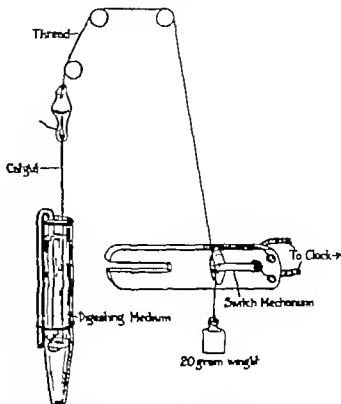


Fig. 4. Diagrammatic representation of the apparatus

in the incubator and kept at a constant temperature of 37.5 degrees C. The switches are connected with corresponding electric

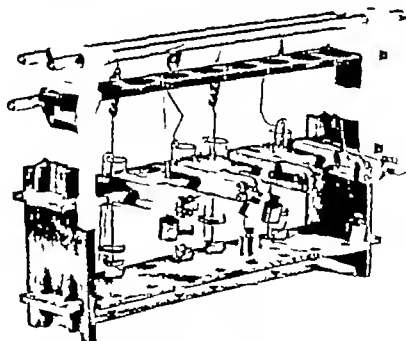


Fig. 3. Rear view showing the switch mechanism. The second and fourth strands have been digested, allowing the weight to fall which interrupts the contact.

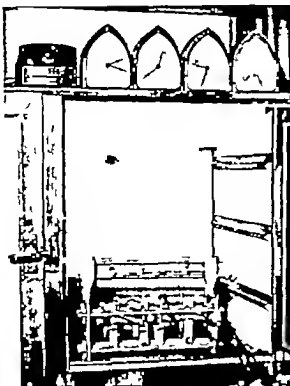


Fig. 5. Photograph of complete setup in the incubator showing the recording clocks above.

clocks so that when the circuit is broken the time will be automatically recorded (Fig. 5). As is shown four determinations may be made at one time with this apparatus, but the number may be easily increased.

RESULTS

It is not our purpose to report fully the digestion rates of various sizes of plain and chromic catgut produced by ten leading American and foreign ligature producers, which we determined by this method. However some of the more significant results are presented to stimulate further investigation.

1. Differences have been found in the rate of digestion of the catgut produced by ten leading catgut manufacturers, but the products of each firm have shown a fairly constant rate of digestion.

2. Catgut produced by two foreign ligature manufacturers resisted digestion longer than any sample supplied by domestic manufacturers.

3. Non-boilable catgut consistently resisted digestion longer than the boilable variety.

4. Non-sterilized catgut resisted digestion longer than any form of sterilized catgut except that produced by the foreign manufacturers.

CONCLUSIONS

A method for determining the time of catgut digestion *in vitro* is described which is simple, containing the elements of physiological digestion but having its variables controlled and having an accurate method of determining its end point. We believe that catgut manufacturers should attempt to standardize their products by a method similar to this, rather than on the amount of chromic acid in the gut or on inaccurate animal experiments. We also feel that this test will act as a guide to ligature producers who are attempting to produce a superior type of suture which may be depended upon to resist digestion in operative wounds until all possibility of disruption has passed and will thus reduce the incidence of this catastrophe.

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MESENTERICOPARIETAL HERNIA

DUODENAL HERNIAS OF TREITZ

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IN 1776, Neubauer reported an "exceptionally rare case of a peritoneal hernial sac holding all of the small intestines. From his description and illustrations we might now place his case under the classification of left duodenojejunal hernia. Following this case report there were other cases scattered throughout the literature reported by Bor denave, Monro, Cooper, Curvilinear, etc. but it was not until the publication of the great work of Treitz in 1857 that their true significance was suspected. It was Treitz who gave us the first accurate description of the fossæ about the duodenojejunal junction, the "vascular arch of Treitz" and the earliest theory of the origin of duodenal hernias.

ETIOLOGY

Most of the subsequent studies (Barrs, Broesike, Bramlett and Ashhurst, Brown, Carson, Cofer and Phillips, Davis, Dayton, Desjardin, Deaver, Erdely, Grad, Hallock, Harris, Levin, Heller, Huntington, Lazarus and Rosenthal, Long, Lower and Higgins, Masson and McIndoe, Morton, Moynihan, Nagel, Novak, Nuzum, Phillips, Pidcock, Primrose, Pringle, Sumner, Short, Taylor) of duodenojejunal hernia have been based on or modified from the original investigations of Treitz who explained the occurrence of the fossæ about the duodenojejunal flexure as due to the failure of complete fusion of the peritoneal leaves during the process of rotation. Treitz believed that these fossæ were deepened and widened by the pressure and peristaltic movement of the intestines to such a degree as to produce a true hernial sac.

Waldeyer (1868) on the other hand considered the elevation of the peritoneum by blood vessels (inferior mesenteric vein and left colic artery) as the important factor. Toldt explained them on the basis of physiologic adhesions, while Treves in his Hunterian Lectures attempted to explain the poten-

tial hernia sac as remains of the early folds of the mesoduodenum. Moynihan in his splendid monograph on retroperitoneal hernia attributes their production to a failure of the root of the mesentery to unite with the posterior abdominal wall. Nixon moreover thought that they might be produced by traction folds.

It has been the belief of most authors that these so called duodenojejunal hernias were post fetal developments by a herniation of the intestine into a preformed paraduodenal or retroduodenal fossa. Nine separate and discrete fossæ have been described about the duodenojejunal flexure from the work of Huschke, Treitz, Gruber, Lanzert, Jonnesco and Broesike introducing into the medical literature a very puzzling nomenclature. In spite of the finding of these hernias in a newborn child by Vogt, in a child of 14 days by Broesike and in a child of 2 months by Treitz the possibility of their interpretation on an embryological basis was never considered until the relatively recent works of Andrews, Eisler and Fischer and Bender. In 1923 E. Andrews after observing a case of so called duodenal hernia raised the point that the term duodenal hernia was a "misnomer." He advanced the view that the condition was a congenital anomaly due to the imprisonment of the small intestine beneath the mesentery of the developing colon. Andrews in his argument states, the view that these small peritoneal pouches of which there are hundreds scattered about the abdomen are the origin of these hernias is absurd and grotesque. In support of his views he advanced the following facts:

1. 'Differential pressure is completely lacking within the abdomen so that any *vis a tergo* to account for the formation and growth of such hernias is totally absent.

2. 'There are literally hundreds of similar folds and fossæ in the abdomen many of

which are of greater size and they are practically never the site of hernias.

3 "In all but a very small minority of the cases reported, the degree of herniation has been total or subtotal.

4 Vogt reported a case in which such a hernia was total in a newborn infant.

5 "Herniated viscera are never anything but small bowel. The presence of omentum has never been noted.

In the German literature Heller stresses that Bender is the first to bring forward a new concept with regard to internal hernia, which is based chiefly upon the researches of Eisler and Fischer. They connect the start of a large internal hernia of Treitz with the failure of adhesion during fetal life of the mesentery of the large intestine to the parietal body wall. It was Eisler and Fischer and Bender who applied the term *mesenterico-parietal* hernias to this condition. Hertzler is also extremely doubtful that the gut ever pushes its way into one of these fossae there being no greater pressure within the abdomen than in the potential sac, as is the case of hernias through the abdominal wall. He also feels that it is far more probable that in the rotation of the colon descent of the cecum and fusion of the right and left portions of the large intestine with the posterior abdominal wall part or all of the small intestines are left in a retroperitoneal pocket.

In order to understand the production of these hernias, it is necessary to grasp the basic embryological changes in the development of the gastro-intestinal tract. As is well known, it is at an early stage divided into the foregut, midgut, and hindgut supplied respectively by the coeliac axis, superior mesenteric artery, and inferior mesenteric artery and having the respective functions of digestion, absorption and excretion. In the evolution of this primitive arrangement into the completed alimentary tract the intestinal viscera go through a series of rotations and fixations. According to Dott the abdominal portion of the alimentary canal may suffer a large number of perversions during its development. The incidence of the essential errors of disposition is confined almost entirely to the midgut.

Normally during the fifth week of fetal life when the yolk vesicle and vitello-intestinal duct become of less importance and begin to degenerate the developing intestines are no longer pulled outward into the umbilical cord. But, due to their duodenocolic attachment to the posterior abdominal wall they are drawn back into the abdominal cavity as the embryo elongates and the abdomen enlarges. The phenomena of rotation occurs simultaneously with the replacement of the intestines into the abdomen. The first stage rotation includes the rotation of the liver, stomach, duodenum and pancreas through an angle of 90 degrees into their permanent positions. During the second stage rotation of the midgut takes place on the superior mesenteric artery as an axis through an angle of 180 degrees the pre-arterial segment normally being carried behind the cecum and coming to lie in the abdominal cavity in front of the mesentery of the hindgut. During the latter part of the second stage the cecum is drawn within the abdomen and comes to lie first just to the left and above the umbilical orifice and later just under the liver. The third stage is characterized by the further descent of the cecum and by the fixation of certain portions of the intestine to the posterior abdominal wall by fusion of their mesentery with the posterior parietal peritoneum. By the twelfth week the mesenteries of the ascending colon and descending colon have become obliterated by fusion to the posterior parietal peritoneum. A portion of the post arterial mesentery remains as the transverse mesocolon while the prearterial mesentery remains essentially free attaching only along its base as the root of the mesentery. To recapitulate normally the colon grows across the abdomen superiorly and then down thus avoiding imprisoning the small intestine in its mesentery.

According to Andrews, "If no rotation of the umbilical loop of the midgut occurs or if rotation occurs through an angle of 180 degrees in the reverse direction the cecum would then come to lie in the lower abdomen to the right of the midline. The colon at first runs straight to the rectum. As it gains in length it forms a loop and when the cecum seeks its normal primitive position in the left

upper quadrant the small bowel is caught beneath the mesentery of the colon." This is the new embryological concept of the mode of origin of the left duodenal hernia. (See accompanying diagrams.) In short, it is produced during fetal life by the incarceration of the small intestines behind the leaves of the mesentery of the colon, which are thereby prevented from becoming obliterated by fusion against the posterior parietal peritoneal wall. As Garber recognized the key to the solution of the mode of production of these hernias lies in the careful dissection and description of the inferior mesenteric vein and artery. Unfortunately, in the description of the greatest number of cases reported there is no accurate description as to the course of the blood supply. Since most of these cases have in the past been encountered either in operating upon a seriously obstructed patient or in a routine postmortem examination little attention could be paid to anatomical details.

DESCRIPTION OF CASES

Recently an opportunity was presented to us to work out carefully the anatomical details of 2 cases of so called duodenojejunal hernias of Treitz which were found in the routine dissection of cadavers in the Department of Anatomy at the Medical College of the University of Cincinnati. Our curiosities were aroused and careful detailed dissections were made in the attempt to solve the controversy as to their etiology.

CASE 1. P. P. male negro entered the hospital with a history of shortness of breath for 7 years. Recently dyspnea became more severe. Patient died 36 hours after entering the hospital. No history suggestive of chronic or acute intestinal obstruction was elicited. Physical examination revealed positive findings limited to heart, lungs and peripheral vessels. Diagnosis: general vascular sclerosis, cardiac decompensation, bronchial asthma.

When the abdomen was opened and the omentum raised, a large, globular mass about the size of a man's head was noted to occupy all of the left side of the abdomen extending to the right well beyond the midline (Fig. 1). The exact measurements of the mass were 15 by 20 by 12 centimeters. On closer examination it was noted that this mass was really a sac containing all of the small intestine except for 5 to 6 centimeters of terminal ileum. The wall of this sac was as smooth and glistening as the parietal peritoneum. It was translucent and through

it could be noted the outline of the incarcerated small intestine. The distal two-thirds of the transverse colon and all of the descending and iliac colon were incorporated in the anterior and lateral walls of the sac. The colon in the left upper quadrant was noted to be lower than the hepatic flexure, the normal splenic flexure being entirely absent. The distal transverse colon and descending colon were contracted. The iliac and sigmoid colon were extremely redundant due to the anterior displacement of the distal colon by the hernial sac. They occupied the lower portion of the right iliac fossa and pelvis. The cecum, ascending colon and hepatic flexure were essentially normal except for their relatively large size. The greater part of the appendix lay retrocecal except for its tip which dipped over the pelvic brim. A firm band-like adhesion was noted to extend from the sac to the ileocecal region, inferior and posterior to which could be seen the terminal ileum as it coursed from the posterolateral wall of the sac to enter the cecum. Just at this point a small cul-de-sac (which just admitted one finger) was found extending about 4 centimeters into the sac. But at no point could any aperture or opening be discovered connecting the interior of the sac with the remainder of the abdominal cavity.

On dissection of the sac the anterior wall was noted to be made up of two serous layers (Fig. 2) between which coursed the ascending and descending branches of the left colic artery and vein as they ran across the sac from right to left to their ultimate distribution on the descending colon (Fig. 3, Case 1). When the inner serous layer of the anterior wall was cut through the contents of the small intestine were exposed. The posterior wall was composed of only one peritoneal layer which continued on to the left lateral wall as one of the peritoneal layers of the sac as far as the descending colon; the other peritoneal layer being derived from a reflection of peritoneum from the lateral abdominal wall. All of the jejunum and practically all the ileum lay distributed in their normal positions within the sac. The entire small intestine was normal as to size and was covered with glistening peritoneum. Adhesions were conspicuous by their absence. The duodenojejunal junction was found just to the left of the body of the second lumbar vertebra and was held in place by the ligament of Treitz and a superior duodeno-mesocolic fold the latter marking out a superior paraduodenal fossa. No definite inferior fold was noted. Upon resection of the jejunum and ileum close to the point of attachment of their mesenteries the root of the mesentery was found to occupy essentially its normal position, extending from the duodenojejunal flexure to a point just medial to the right sacro-iliac point. The distribution of the superior mesenteric artery and vein was normal but upon working out the course and distribution of the inferior mesenteric vessels we found the following anomalies.

The inferior mesenteric artery was noted to arise from the aorta 5 centimeters from its bifurcation to



Fig. 1. The mesentericoepitestinal hernial sac in Case 1 with no opening into the sac other than the incision to expose its contents—the small intestine. Incorporated in the anterior and lateral walls of the sac are the distal transverse and descending colons.

course downward and to the right following close to the attachment of the root of the mesentery giving off in turn the superior hemorrhoidal branch, two sigmoid arteries and then the left colic branch (Fig. 2). The left colic artery then passed down and around the root of the mesentery thence anterior to the terminal ileum on to the lateral and anterior wall of the hernial sac where it lay in between the two peritoneal layers. As it reached the anterior wall it divided into an ascending and descending branch which were distributed to the descending colon. There were two sigmoid arteries. It was

found that the proximal sigmoid colon was supplied by what appeared to be the distal sigmoid artery while the distal sigmoid colon was supplied by the proximal sigmoid artery. This distortion was produced by the same mechanism (the distention of the hernial sac by its contents) which changed the course of the left colic artery.

The superior hemorrhoidal vein was found coursing up from the rectum in its normal position until it reached the proximal sigmoid artery about which it curled and coursed downward following the left colic artery under the root of the mesentery close to

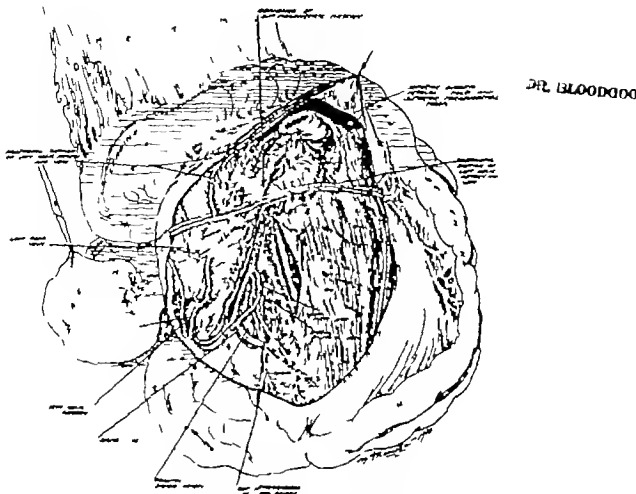


Fig. 2. Dissection of the sac in Case 1 showing the normal superior paraduodenal fossa and the peculiar distortion of the blood supply to the distal colon.

which point the sigmoid vein entered it. It then ran upward along the right side of the root of the mesentery to pass through the posterior wall of the upper portion of the sac to join the splenic vein at its usual point of junction.

CASE 2 W. J. colored aged 24 years was admitted to the Branch Hospital September 7, 1933. He died October 4, 1933. He had lost weight. Physical examination and X-ray films revealed a large advanced tubercular lesion of the left lung of the basal type. A mass was noted in left upper quadrant which moved with respirations and was thought to be an enlarged spleen. There was no history whatsoever of gastro-intestinal disturbance.

The abdomen was opened and the liver and stomach were found to be normal as to size and position. The omentum was raised and the large intestine was seen to occupy chiefly the right side of the abdomen while the left side of the abdomen was filled with an elliptical mass about the size of a football (Fig. 3). The exact measurements of the sac were 18 by 24 by 13 centimeters. The mass was found to be a large peritonealized pouch which contained all of the small intestine with the exception of 7 centimeters of terminal ileum. The wall of the sac was smooth and glistening and was made up of 2

layers of peritoneum (Fig. 5 Case 2) in the folds of which lay the greater portion of the transverse colon and descending colon. There was no definite orifice or aperture into the sac. The terminal ileum passed out from the posterolateral aspect of the hernial sac to enter the caecum. There was a band-like adhesion noted to extend from the sac to the midpoint of the ascending colon. The caecum, ascending colon, and hepatic flexure were essentially normal. The course of the transverse colon was very short for it soon angulated and coursed downward on the right of the summit of the sac. As a result of being carried forward beyond the summit of the hernial sac, the iliac and sigmoid colon were especially redundant. The appendix lay retrocecal.

The jejunum and ileum were about normal as to size and length. The duodenojejunal flexure was normal, with its ligament of Treitz and superior duodenojejunocolic fold which marked off a superior paraduodenal fossa. The root of the mesentery was shorter and its direction was not as oblique as normal extending from the left aspect of the second lumbar vertebra to the right aspect of the lower portion of the body of the fourth lumbar vertebra. Both the inferior mesenteric artery and vein lay to the right of the root of the mesentery in the right



Fig. 5. The mesenteroepicardial hernia sac in Case 3 containing most of the small intestine, with the transverse and descending colons carried forward and to the right of the summit of the sac.

posterolateral wall of the hernial sac, the artery lying behind the terminal ileum while the vein lay in front giving off their left colic branches which coursed over the sac in between the two serous layers to their ultimate distribution on the descending colon. The sigmoid and superior hæmorrhoidal vessels coursed under the posterior peritoneal layer forming the posterior and inferior walls of the sac. For further description see Figures 4 and 5.

The anterior and lateral walls of the sac were composed of two peritoneal layers, while the posterior layer was composed of only one serous layer (see Figs. 4 and 5, Case 3). The lateral surface of the sac was smooth and there was a striking absence of any adhesions. The pouch extended upward under the colon to the line of fusion of the mesocolon along the body of the pancreas. There was no point of communication with either the lesser or greater peritoneal sacs. The bed of the sac was formed by

the bodies of the second to the fifth lumbar vertebrae, the aorta and inferior vena cava, the third portion of the duodenum, the left psoas and quadratus lumborum muscles, and the lower pole of the left kidney.

EMBRYOLOGICAL EXPLANATION

The significant findings in these two cases which lead us to consider them as true congenital anomalies rather than post fetal developments, are as follows: the site and extent of the sacs, the absence of any definite neck and the absence of both an entering and a departing loop, along with the absence of any omentum within the sac. The dissection of the sacs and the peculiarities of their blood supply served to clinch the point in question. Also

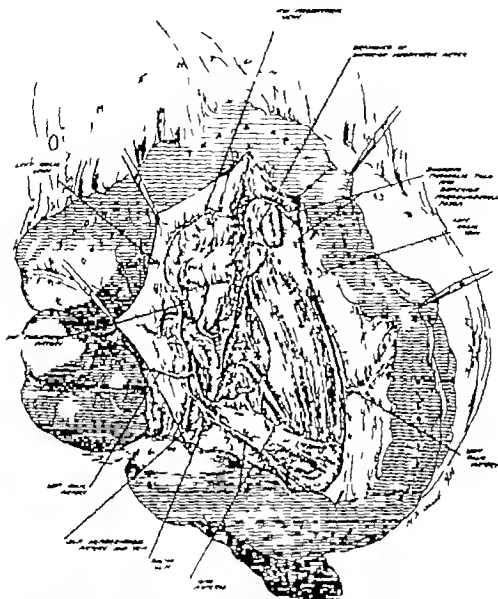


Fig 4. Dissection of the sac in Case 2 showing the displacement of both inferior mesenteric artery and vein to the right of the root of the mesentery and the normal superior paraduodenal fossa.

the finding of normal duodenal jejunal fossae serves to exclude the mechanism of a widening and deepening of a preformed paraduodenal fossa in these cases.

The embryological sequence of events is as follows. During the second stage of rotation if the rotation occurred through an angle of 180 degrees in the reverse direction the cecum will be thrown behind the prearterial segment while the latter is thrown upward into coils in the left upper quadrant. The colon at first runs straight to the rectum. As it lengthens it forms a loop (see Fig 7 diagram B) and when the cecum seeks its normal position just to the left and above the umbilicus

the small bowel is caught behind the mesentery (diagram C) of the colon, thereby forming the two layer anterior wall of the sac. The descending colon later fuses along the posterior abdominal wall. Depending on the extent to which the incarcerated intestines extend and develop under the mesentery of the colon to that extent will be determined the distortion of the blood supply and also the size of the sac.

In Case 1 the small intestine must only have extended down as far as the left colic branch of the inferior mesenteric artery (Fig 7). As the hernial contents increased in size the wall of the sac stretched thereby throw

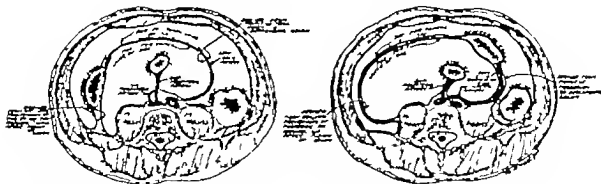


Fig. 5. Cross sections at approximately the level of the fourth lumbar vertebra in Cases 1 and 2 showing the relative portions of the sac wall derived from the primitive

mesocolon to the descending colon and from the posterior parietal peritoneum.

ing the left colic artery first under the root of the mesentery thence over the lateral and anterior wall of the sac to its ultimate distribution to the descending colon. Furthermore the distortion of the blood supply to the sigmoid colon so that what appeared to be the distal sigmoid artery supplied the proximal sigmoid colon serves to bear out the same point. The diversion of the course of the inferior mesenteric vein so that it courses upward on the right side of the root of the mesentery (when normally it should lie on the left) serves to prove the same point. The left lateral wall of this sac is formed by the stretching of the peritoneal layers reflected from the posterior abdominal wall on to the descending colon as brought about by the increase in size of the hernial contents (Fig. 5).

In Case 2 the small intestine must have extended beneath the entire mesocolon of the盲gut thereby throwing the inferior mesenteric artery and vein with all of their branches to the right of the root of the mesentery (see Fig. 8). The greater size of the hernial contents (small intestine) in this case along with the fixation of that portion of the sac wall derived from the mesocolon by all the branches of the inferior mesenteric artery may have accounted for the greater stretching of that portion of sac wall derived from reflection of peritoneum from posterior abdominal wall onto descending colon (Fig. 5, Case 2).

DIAGNOSIS

To date 140 cases of duodenojejunal hernia (35 cases of right duodenal hernia and 105

cases of left) have been reported in the literature. Of these only 5 have been diagnosed correctly before operation: one by Abrams, two by von Haberer, one by Vautrin, and one by Sclaudenmeyer.

As to the clinical course the condition may remain symptomless and be found only at necropsy. On the other hand there may be present a history of intermittent attacks of colic-like abdominal pain without vomiting suggesting a chronic obstruction. Then again there may be no trouble until the sudden onset of an acute obstruction. Rare cases present symptoms like those of a chronic duodenal stasis.

According to Garber the history of periodic distention of the abdomen associated with a sense of heaviness, when coupled with the finding of a tympanitic elastic tumor in the left hypochondrium is very suggestive of partially obstructed duodenal hernia. In the stage of acute obstruction the signs of ileus along with the presence of an elastic tumor help to establish the diagnosis. It is claimed by Sheele that the roentgen ray is of some aid in reaching a diagnosis. X-ray films following a barium meal show retention in the stomach and duodenum along with a bow-shaped closing off of the upper intestinal shadow.

TREATMENT

Very little can be said as to treatment. If acute obstruction exists, an abdominal laparotomy must be performed after the proper pre-operative preparation with decompression and restoration of the fluid and acid base balance.

1 NORMAL ROTATION

3

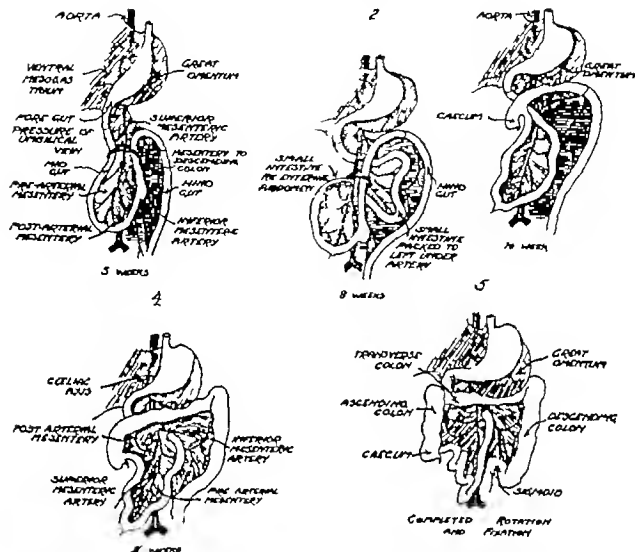


Fig. 6 The normal rotation and fixation of the abdominal portion of the gastro-intestinal tract

The extent of the procedure will depend largely upon the status of affairs found. The strangulation must be relieved. This may be done by widening the mouth of the sac if the vessels permit. Because of the technical difficulties produced by the distortion of the anatomy the mortality still remains high. This can be reduced only by a more thorough grasp on the part of the operating surgeon of the anatomical anomalies at hand.

SUMMARY

In 1776 Neubauer described a peritoneal hernial sac within the abdomen which contained all of the small intestine. Subsequently

other cases were reported but it was not until the great work of Treitz in 1857 that the subject of duodenojejunal hernias might be said to exist. Treitz gave us the first concept as to their etiology, believing them to be produced by the pressure and peristaltic movement of the small intestine widening and deepening one of the many preformed fossae about the duodenojejunal flexure.

Most of the subsequent studies were either based directly on or modified from the work of Treitz. Though these hernias were reported in newly born infants the possibility of their interpretation on an embryological basis was never considered until the relatively recent works of Andrews, Eisler and Fischer and

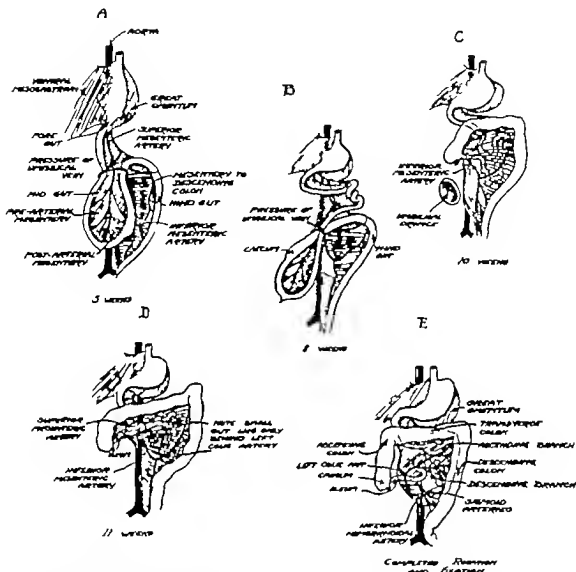


Fig. 7 The embryological sequence of events explaining the formation of the mesentericoparietal hernial sac in Case 1 with the resulting distortion of the blood supply

Bender They present the rational explanation that these internal hernias are congenital anomalies produced by the imprisonment of the small intestine beneath the mesentery of the developing colon. Against the old concept of the hernia produced by a widening and deepening of a preformed pouch are the following facts (1) differential pressure is completely lacking in the abdomen (2) there are literally hundreds of similar fossae in the abdomen (3) in all but a few cases the herniation has been total or subtotal (4) the hernial

ated viscera are never anything but small intestine. Omentum has never been found in the hernial sac.

The basic embryological changes in both the normal and abnormal development of the abdominal portion of the gastro-intestinal tract are presented. Normally the colon grows across the abdomen superiorly and then down thus avoiding imprisonment of the small intestine in its mesentery. If however the rotation of the umbilical loop is reversed the small intestine is incarcerated behind the

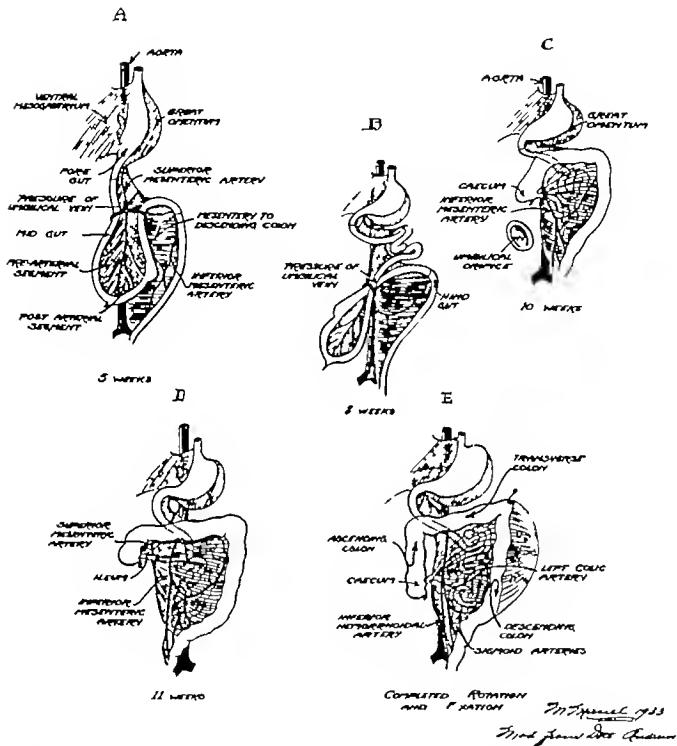


Fig. 8. The course of events explaining the production of the hernial sac in Case 2 with the consequent distortion of the blood supply

leaves of the mesentery of the colon which forms the greater portion of the wall of the hernial sac (see accompanying diagrams)

As Garber recognized, the key to the solution of the mode of production in these hernias lies in the careful dissection and description of the inferior mesenteric artery and vein. Unfortunately, in the description of the

greatest number of these cases there is no accurate description of the course of the blood supply. Recently, 2 cases of so called duodenojejunal hernias of Treitz were encountered in the Department of Anatomy upon which careful detailed dissections were made.

The significant findings in these 2 cases which lead us to consider them as true con-

genital anomalies rather than post fetal developments, were as follows (1) the site and extent of the sac (2) the absence of a definite neck (3) the absence of omentum within the sac (4) the distortion of the blood supply to the colon. This last point served to clinch the point in question.

To date 140 cases of duodenojejunal hernias have been reported in the literature. Clinically they may present no symptoms whatsoever or they may present the signs of acute or chronic intestinal obstruction which requires operative relief. The mortality of this procedure still remains high. This can be reduced only by a more thorough grasp on the part of the operating surgeon of the anatomical anomaly at hand.

CONCLUSIONS

1 In the light of the new embryological concepts the anatomical details of the cases presented indicate that the so called duodenal hernias of Treitz are true congenital anomalies produced by the incarceration of the small intestine behind the mesentery of the colon.

2 In view of the mechanism of production of these hernias the term mesentericopanetal hernias has been applied to them.

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A STUDY OF VARIOUS KIDNEY FUNCTION TESTS IN RELATION TO THE TOXÆMIAS OF PREGNANCY

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CHRONIC nephritis is a grave and fairly common complication of pregnancy, yet it is one of the most difficult conditions to recognize in its earlier stages. An elevation of blood pressure *per se* is not sufficient evidence for making a diagnosis of nephritis as the differential diagnosis has to take into account many other conditions such as essential hypertension, eclampsia and pre-eclampsia. Hypertension plus albuminuria and a nitrogenous retention in the blood have been the criteria for the diagnosis of chronic nephritis, but these more especially the latter two usually appear so late that the damage to the kidney is irreparable. For example, MacKay and MacKay state (and we concur with them) that a patient with chronic interstitial nephritis may have a blood urea concentration within normal limits even though more than one half the functioning tissue of the kidney has been destroyed.

Many tests have been developed for the purpose of detecting impairment of kidney function. One of the difficulties of interpretation lies in the fact that all of the tests are *not* based on the same principle. For instance in the phenolsulphonethalein test a foreign substance is injected in the creatinine excretion test one injects a substance which is normally excreted in the urine but the presence of which in the blood is questionable (1, 4) whereas the urea clearance is a measure of the amount of blood cleared of its urea in one minute.

Stander and Peckham in their follow up study of a large series of patients with nephritis in pregnancy have shown that 40 per cent of these women died within 10 years after the diagnosis was definitely established. With these findings in mind it is of utmost importance that the obstetrician should recognize kidney impairment as early as possible. It was with a desire to find which if any of the many kidney function tests were of sufficient

sensitivity to differentiate the toxæmias of pregnancy that Stander, Ashton, and Cadden undertook a comparative study of the Mosenthal concentration test, urea concentration factor, diastase test, thiosulphate test of Nylin, the guanidine and creatinine excretion tests of Major, the phenolsulphonethalein test and the urea clearance test. These authors conclude that the latter three tests proved of real value in the differentiation between mild nephritis and the other toxæmias of pregnancy and recommended the urea clearance and creatinine excretion tests for routine use in all patients suffering from toxæmia of pregnancy in which the diagnosis is not clear.

For many obvious reasons it would be advisable to carry out only one type of test in patients in whom one suspects chronic nephritis. It was our purpose in the present study to determine which one of the three tests which have been recommended by the authors mentioned gives the most accurate evaluation of kidney function and thus could be used exclusively.

PROCEDURE

The tests were carried out in the following manner:

Urea clearance 1 6 a.m. The patient is awakened and the regular breakfast is served except for tea, coffee or cocoa.

2 7 a.m. A catheter is inserted as described under the phenolsulphonethalein test. The bladder is emptied and this specimen is discarded. The patient may have 200 cubic centimeters of water.

3 8 a.m. The bladder is emptied, the exact time is noted, and the entire specimen is sent to the laboratory. The patient may have 200 cubic centimeters of water.

4 8-30 a.m. A blood specimen is drawn by the doctor.

5 9 a.m. The bladder is emptied, the exact time is noted and the entire specimen is sent to the laboratory.

¹ Page states that the urea clearance test may be carried out following the usual breakfast with coffee.

Per Cent Excreted.

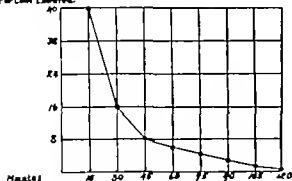


Fig Phenolsulphophthalein test

Note. The time is recorded from the moment that the catheter is clamped in the first hour until the catheter is clamped in the next hour. Thus if after inserting the catheter and collecting the urine the clamp is applied at 7:03 a.m. this time is regarded as the beginning of the first specimen which is to be sent to the laboratory.

Phenolsulphophthalein test: The patient has a rubber catheter inserted and the bladder is emptied. The catheter remains in place for the duration of the test. (a) The catheter is fastened to the patient's leg with adhesive tape so as to hold it in place. (b) A Kelly clamp is used to close off the catheter.

2 The bladder is emptied and 6 milligrams of phenolsulphophthalein is given intravenously by the doctor. The patient now drinks 100 cubic centimeters of water.

3 Fifteen minutes after the intravenous injection the first specimen is collected, properly labeled, and sent to the routine laboratory. The patient is given 100 cubic centimeters of water.

4 Fifteen minutes later the second specimen is collected, properly labeled, and sent to the routine laboratory. The patient is given 100 cubic centimeters of water.

Mgms Creatinine

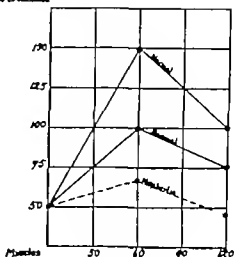


Fig 2 Creatinine test

5 Fifteen minutes later the third specimen is collected, properly labeled and sent to the laboratory. The patient is given 100 cubic centimeters of water.

6 Fifteen minutes later the fourth specimen is collected, properly labeled, and sent to the routine laboratory. The patient is given 100 cubic centimeters of water.

7 Fifteen minutes later the fifth specimen is collected, properly labeled, and sent to the routine laboratory.

8 Fifteen minutes later the sixth specimen is collected, properly labeled, and sent to the routine laboratory.

9 Fifteen minutes later the seventh specimen is collected, properly labeled, and sent to the routine laboratory.

10 Fifteen minutes later the eighth specimen is collected, properly labeled, and sent to the routine laboratory.

TABLE I—PHENOLSULPHOPHTHALEIN TEST

Type of patient	1st half hour	2nd half hour	Total	No. of tests
Normal pregnancy				
Antepartum	30	16	77	3
Postpartum	45	3	8	
Low reserve kidney				
Antepartum	35	34	73	68
Postpartum	44	34	83	
Nephrotic				
Antepartum	36	3	76	75
Postpartum	37	34	70	76
Pre-sclerotic				
Antepartum	3	34	74	6
Postpartum	4	7	85	18
End-stage				
Antepartum	3	9	6	5
Postpartum	3	9	6	

TABLE II.—CREATININE

	1st hour	2nd hour	3rd hour	No. of tests
Normal				
Antepartum	7	3	3	18
Postpartum	37	147	143	
Low reserve kidney				
Antepartum	58	19	30	80
Postpartum	64	93	20	86
Nephrotic				
Antepartum	6	30	30	70
Postpartum	61	37	30	83
Pre-sclerotic				
Antepartum	33	3	30	18
Postpartum	6	63	200	30
End-stage				
Antepartum	44	30	93	3
Postpartum	37	75		

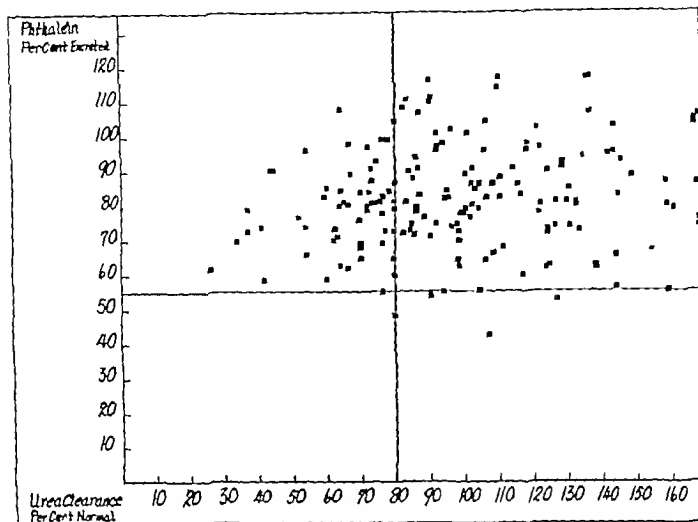


Chart 1

Creatinine test 1 7 30 a.m. The patient voids and the specimen is discarded. The patient may have 200 cubic centimeters of water

2 8 15 a.m. Breakfast is served from floor service.

3 8 30 a.m. The patient voids and the entire specimen is sent to the laboratory. At this time $\frac{1}{4}$ gram of creatinine is given intravenously by the doctor

4 9 30 a.m. The patient voids and the entire specimen is sent to the laboratory. The patient may have 200 cubic centimeters of water

5 10 30 a.m. The patient voids and the entire specimen is sent to the laboratory

Points to be emphasized 1 The entire amount of urine must be sent to the laboratory

TABLE III — UREA CLEARANCE

	Asia-partum	No. of tests	Post-partum	No. of tests
Normal	222 7	0	104 2	1
Low reserve kidney	101 7	00	104 0	104
Nephritis	75 3	87	68 6	75
Pre-eclampsia	81 4	7	76 8	31
Eclampsia	24 7	1	79 0	4

TABLE IV — UREA CLEARANCE TESTS

	Normal	Low reserve kidney	Nephritis	Pre-eclampsia	Eclampsia
Total number of tests	17	270	76	16	43
Tests below 80	1	64	113	10	18
Percent of total	18	23	64	61	75
Tests below 70	1	50	80	8	21
Percent of total	12	18	50	50	44
Tests below 60	1	40	78	8	18
Percent of total	18	14	44	50	47
Tests below 50	1	28	57	1	14
Percent of total	18	10	31	31	30

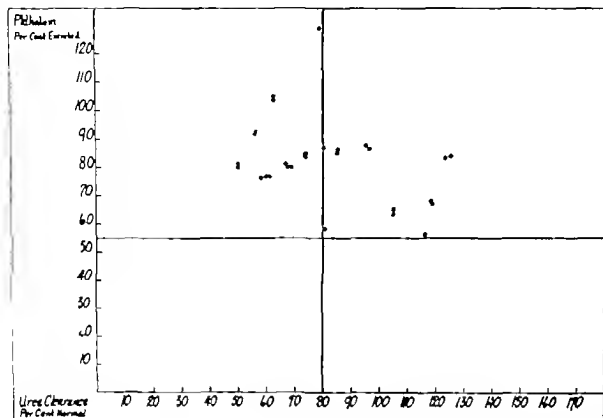


Chart 1

- 2 The exact time the specimen was collected must be placed on the label
- 3 Be sure that the correct label is filled out completely and correctly
- 4 All medications during the interval of the tests must be stopped
- 5 Avoid giving pituitrin and adrenalin

INTERPRETATION OF TESTS

Urea clearance test When the urine volume exceeds 2 cubic centimeters per minute the following formula is used to calculate the amount of blood that is cleared of its urea in one minute

$$C_m = \frac{U \cdot V}{B}$$

C_m —Maximum clearance
 U —Urea nitrogen per 100 c cm urine
 V —Volume of urine per minute
 B —Urea nitrogen per 100 c cm blood

If the output is less than 2 c cm per minute

$$C_s = \frac{U \cdot V}{B}$$

To express the urea clearance as percentage of normal the above formulae are changed as follows

$$C_m = \frac{U \cdot V}{B} \times 33$$

$$C_s = \frac{U \cdot V}{B} \times 35$$

Phenolsulphonephthalein test The amount of the drug expressed as a percentage of the total amount injected eliminated during each quarter hour interval is recorded as shown in Figure 1. The curve plotted in this figure is normal. Any variation from this graph is an indication of deficient kidney function.

The creatinine test The amount of creatinine excreted in each specimen is recorded as shown in Figure 2. The normal kidney should excrete two to three times as much creatinine in the first hour after injection as during the hour preceding the injection.

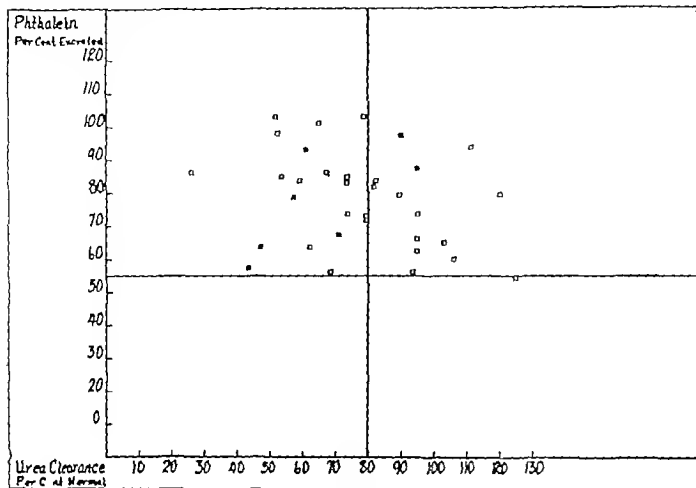


Chart 3

RESULTS

Our results are based on the findings in—23 cases of normal pregnancy 216 cases of low reserve kidney, 90 cases of chronic nephritis, 28 cases of pre-eclampsia, 9 cases of eclampsia.

Phenolsulphonaphthalein test In Table I are recorded the average values for the phenolsulphonaphthalein test in normal pregnancy as well as in each of the various types of toxemia. In the normal pregnancy group a total of 17 tests were made. Although only 5 of these were carried out before delivery, the average values agree closely with the averages obtained in the postpartum period. In the low reserve kidney group, we had 68 tests in the antepartum and 211 in the postpartum period, there is a total of 153 tests in the nephritis group 75 of which were performed antepartum and 78 postpartum while for pre-eclampsia and eclampsia there are a total of 54 tests.

The values in the low reserve kidney group differ somewhat from the accepted normal values which are 56 per cent for the first half hour and 14 per cent for the second half hour. The striking feature of the low reserve kidney group is the parallelism of its values with the nephritic group. As one can readily see the values are for all practical purpose, identical. This, to our minds, invalidates the phthalein test as a means of differentiating between low reserve kidney and early chronic nephritis and this test is perhaps of doubtful value in detecting the presence of early kidney insufficiency.

It might be pointed out however, that the first half hour's excretion in the antepartum pre-eclampsia group is only 25 per cent. It is possible that this shows a specific inefficiency of the kidney of the pre-eclamptic that is peculiar to that condition. We are not suggesting this as a hypothesis but merely as an explanation of the solitary deviation of Table I.

TABLE V—RELATIONSHIP BETWEEN BLOOD PRESSURE RANGE AND UREA CLEARANCE TEST

Blood pressure systolic and diastolic	Urea clearance per cent				No. of tests
	Below 80 normal	70 normal	65 normal	60 normal	
$\frac{-90}{-90}$	43	40	43	36	84
$\frac{+10}{-90}$	53	4	35	79	7
$\frac{-140}{+90}$	67	64	33	33	3
$\frac{+140}{+90}$	68	33	46	33	37

Low reserve kidney					
$\frac{-90}{-90}$	36	6	3	16	34
$\frac{+10}{-90}$	34	3	7	6	1
$\frac{-140}{+90}$	3	3	3	8	13
$\frac{+140}{+90}$	30	3	1	9	22

The creatinine excretion test. The results of this test are of interest. It will be noted in Table II that in each case the kidney is more efficient postpartum except in the normal in which we have only a few tests. Here again we see the low reserve kidney and nephritic groups in agreement while the pre-eclamptic group is slightly less efficient. Since there is so great a uniformity of values throughout the table we feel it can be safely said that the creatinine excretion test is not delicate enough to reveal kidney impairment in the early stages of nephritis.

Urea clearance. By a urea clearance test we mean the average value for two consecutive 1 hour periods. Only those tests which agreed within 10 per cent of the average value were accepted. In Table III are given the figures obtained from the urea clearance tests. Of the three tests studied this is the only one that shows any constant and definite variation in toxemia groups. This differs greatly from our findings for the phthalein and creatinine tests in the low reserve kidney and nephritic groups. For the former class, the average values for the urea clearance are

101.7 and 104.9 per cent normal for antepartum and postpartum respectively while for the nephritic group the values are 75.3 and 68.6.

From a study of 94 observations on 21 cases Bruger and Mosenthal concluded that the range of 80 to 120 per cent normal was too high. These authors suggested 75 per cent as the lower limit of normal. 50 to 75 per cent normal as doubtful range and below 50 per cent normal as a manifestation of kidney impairment. In view of this we have considered the distribution of the test in various ranges. The figures shown in Table IV bring out quite forcibly the fact that no matter what value below 80 is taken as the lower limit of normal the number of nephritic patients is predominately greater below that value than any other group. Our findings agree with those of Bruger and Mosenthal. We believe that any patient showing a urea clearance persistently less than 70 per cent normal should be classified as having chronic nephritis. From the table one sees that 50 per cent of a total of 176 tests on patients diagnosed as nephritic are below 70 per cent normal in this group.

In Table V we have listed the blood pressures in four groups. The first group has a normal systolic and normal diastolic $\frac{-140}{-90}$ the second group has an elevated systolic and normal diastolic $\frac{+140}{-90}$ the third group has a normal systolic and elevated diastolic $\frac{-140}{+90}$ while the fourth group includes patients with an elevated systolic and an elevated diastolic pressure $\frac{+140}{+90}$. The urea

clearance tests are recorded as the percentage of the total number of tests in each blood pressure group which is below certain limits.

An inspection of this table reveals that the distribution of the urea clearance test in respect to blood pressure is quite uniform. At first glance it may seem that the nephritic group having a normal systolic with an elevated diastolic blood pressure is inclined to give lower values for the urea clearance than any other blood pressure group. However

this tendency disappears when urea clearance values below 60 per cent normal are considered. Except for this apparent influence of the diastolic pressure there is no relationship between the blood pressure and kidney function as measured by the urea clearance test.

RECAPITULATION

The urea clearance test was examined by Hurwitz and Ohler who found higher values in normal pregnancy than usual reporting a figure of 127 per cent normal. This agrees quite closely with ours, namely 122.7 per cent normal. On the other hand, Cantarow and Ricchiute found that as pregnancy progressed the kidney function decreased. In the third month of gestation they obtained a value of 111 per cent normal which decreased gradually to 59 per cent normal during the ninth month. In the postpartum period they report values averaging 121 per cent normal. Practically all of our tests were made on patients shortly before and after parturition and we cannot in any way account for the material differences between our findings and those which were reported by Cantarow and Ricchiute.

In respect to the phenolsulphonephthalein test we wish to mention the findings of Van Slyke *et al*. These writers state that it is only after the urea clearance has fallen below 20 per cent normal that the two tests are in agreement. In Charts 1, 2, and 3 we have plotted the values which were obtained either on the same day or consecutive days from the urea clearance and phthalein tests. Chart 1 shows that practically all of the relative values obtained from the low reserve kidney group are in good agreement and lie in the area of normal phenolsulphonephthalein and normal urea clearance. The circles which are plotted on Chart 2 represent normal pregnancy while the dots are chronic nephritis. In contrast to Chart 1 the majority of points representing nephritis on this chart lie in the area of normal phenolsulphonephthalein and low urea clearance which would seem to indicate that the urea clearance test is capable of revealing decreased kidney function while the phenolsulphonephthalein test has yet shown

no signs of kidney impairment. In Chart 3 the dotted squares indicate eclamptic values. One sees immediately that this chart while lacking the number of points is practically identical with the preceding chart. These charts show graphically the greater sensitivity of the urea clearance tests as compared with the phenolsulphonephthalein test.

SUMMARY

1 We have studied the phenolsulphonephthalein creatinine excretion and urea clearance tests in 23 cases of normal pregnancy and in 343 women suffering from one or other type of toxemia of pregnancy.

2 The values obtained are given in Tables I, II, III and IV.

3 Of the phenolsulphonephthalein creatinine excretion test, and urea clearance test only the latter is sufficiently sensitive to differentiate chronic nephritis from the other toxemias of pregnancy.

4 The lower limit of normal for the urea clearance test is probably in the neighborhood of 70 per cent normal.

5 The average urea clearance value for nephritis is 75 and 68 per cent normal for antepartum and postpartum respectively.

6 Fifty per cent of all the nephritic patients showed values below 70 per cent normal.

7 There is no apparent relationship between blood pressure and kidney function as measured by the urea clearance test.

8 There is no kidney impairment according to the urea clearance test in the low reserve kidney group.

9 The average urea clearance values for pre-eclampsia and eclampsia are lower than those obtained in normal pregnancy.

10 We recommend the urea clearance test as the most sensitive method so far devised to recognize early or mild nephritis. To be assured that one is dealing with a nephritic condition it is essential that repeated 2 hour tests be performed.

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FRIEDMAN TEST IN HYDATID MOLE

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A NUMBER of recent reports have indicated the value of the Aschheim Zondek pregnancy test in hydatid mole and chorio-epithelioma. A greatly increased content of prolactin or sex hormone similar to that derived from the anterior pituitary body, in the urine is accepted as differentiating these conditions from pregnancy (10). The Friedman test for prolactin, on account of its greater ease of execution, has in many quarters superseded the Aschheim Zondek as a pregnancy test (1, 3, 5, 6, 7, 12, 13). We have been rather uncertain of what constitutes a positive Friedman test for hydatid mole and have seen no case reports in the literature dealing definitely with this subject.

From perusal of the excellent monograph of Mazer and Goldstein (10) on clinical endocrinology, we were under the impression that the diagnosis rested upon the finding of a positive rabbit test after injection of less than 1 cubic centimeter of urine. We (3) encountered a patient 0.4 cubic centimeter of whose urine gave a positive reaction. Mole was suspected but 10 days later she aborted a dead fetus of 5 months. Mazer (8), in a recent letter to the *Journal of the American Medical Association*, emphasizes the fact that the quantity of prolactin increases with the duration of pregnancy. In the fifth month of a normal pregnancy, he states that 1 cubic centimeter of urine should give a positive rabbit test. The diagnosis of mole should not be made, he says, unless a positive reaction is obtained following the injection of one-twelfth of a cubic centimeter of a 24 hour specimen.

In a recent paper entitled "The Value of the Aschheim Zondek Reaction in the Diagnosis and Prognosis of Chorio-epithelioma," Mazer and Edeiken (9) review the subject, and report a case. In their description of the diagnosis of their own case, the following sentence is the only reference to their laboratory studies: "Repetition of the Aschheim

Zondek test showed that as little as 1 cubic centimeter of her urine evoked a very strong reaction. The stimulated rabbit ovaries resembled a diminutive bunch of grapes. With the gradual decrease in the size of the metastatic tumors, there is a corresponding decrease in excretion of prolactin so that now, after a lapse of 6 months, 20 cubic centimeters of her urine evoke no more than the ordinary pregnancy reaction in the isolated rabbit."

It is to be noted that although these authors employ the phrase "Aschheim Zondek test" in the title and body of their paper, the references to "as little as 1 cubic centimeter of her urine" and to the 'stimulated rabbit ovaries,' make it obvious that the Friedman test was the one employed. In the Aschheim Zondek reaction of course, the test animal is a rat, and 1 cubic centimeter of urine is not a small dose. In the published discussion of the paper there is no comment upon the discrepancy. Dr. Franklin L. Payne (6) mentions a case in which chorio-epithelioma was suspected because 3 cubic centimeters of the patient's urine evoked a positive reaction. A diagnosis of twins, however, was subsequently made. Dr. John C. Hirst (9), in a case in which mole was suspected, obtained a strongly positive Friedman reaction after the injection of "only 2 cubic centimeters of urine (i.e. only one fifth the usual amount)." His case also later proved to be a twin pregnancy.

This discussion and the figures are mentioned not with any intention of criticizing the admirable work of Dr. Mazer, which we have followed with interest and profit but merely to show that there is some confusion in the recent literature as to the normal amount of prolactin in pregnancy urine and as to what should constitute a positive Friedman test for hydatid mole or chorio-epithelioma. The phrases Aschheim Zondek and Friedman tests, are interchanged a little indiscrimi-

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TABLE II—FRIEDMAN TESTS IN A CASE OF HYDATID MOLE

Type rabbit	Weight, kilograms	Date injected	Amount	Date injected	Amount	Date examination	Results
New Zealand, white	3.8	6-19-33	12 ccm.	6-21	10 ccm.	6-22	Positive
Chinchilla, grey	2.04	6-23	1 ccm.	6-24	1 ccm.	6-25	Positive
Chinchilla, grey	2.63	6-23	0.5	6-24	0.25	6-25	Positive
Chinchilla, grey	2.97	6-23	0.03	6-24	0.031	6-25	Positive
Chinchilla, white	3.83	6-29	0.5	6-30	1	7-1	Negative though ovaries stimulated
Chinchilla, white	3.63	6-29	0.01	6-31	0.01	7-1	Negative though ovaries stimulated

Physical examination showed many missing and carious teeth marked endocervicitis, and a uterus enlarged to the size of a 6 months pregnancy. Physical findings otherwise were negative. There was an anemia, with hemoglobin 57 per cent, red cells, 3,350,000 and color index 0.9. Urinalysis and the blood Wassermann and Kahn tests were negative.

X-ray examinations in June and later in July (Dr. Barfield-Carter and Dr. J. A. Meadows) showed a soft tissue tumor in the pelvis but no outline of a fetus. The general condition of the patient improved with hospitalization. No fetal heart sounds were heard there were no fetal movements and no fetal parts could be distinguished. The patient was transferred to the Gynecologic Service shortly after her admission.

Menopause, complicated by a large bleeding fibroid was considered as a possible diagnosis. Dead fetus was considered and hydatid mole or chorio-epithelioma was suspected.

Friedman tests with decreasing quantities of a morning specimen of urine were made, with the following results. Mature rabbits were used but not postpartum animals. All were subjected to laparotomy for examination of the ovaries immediately before the first injections.

The Friedman test, as shown in Table II, was strongly positive after injections into rabbits of respectively 22, 2, 0.5 and 0.06 cubic centimeters of a morning specimen of urine. Smaller quantities, 0.03 and 0.02 cubic centimeter respectively produced a marked ovarian reaction but not what we consider a positive pregnancy test.

On July 27 the patient complained of pains in the back later of pains like labor pains, she began bleeding freely and passed a mass resembling gelatin beads. She gave the appearance of impending shock. She was taken to the operating table, where her cervix was seen to be soft dilated, bluish, oozing blood, which contained clots with the described gelatin bead bodies in them. The uterus was emptied with sponge forceps and a curette. The specimen removed weighed 912 grams, and was diagnosed in the laboratory by Dr. George S. Graham as hydatidiform mole.

Four days later her condition had much improved. She received a transfusion of 520 cubic centimeters

of whole blood. Later she was given three treatments of massive X radiation and 1400 milligram hours of radium (Dr. J. A. Meadows). She was discharged August 10 to remain in her home for 3 weeks and then return for a panhysterectomy but overstayed her time.

Her condition on readmission August 29, was good. The cervix was infected from slight radium burns and was cauterized thoroughly before operation, September 2 when panhysterectomy and appendectomy were performed.

The pathological report (Dr. Graham) showed a persistent focus of trophoblastic infiltration of the myometrium.

Her recovery was uneventful except for a diarrhea which was probably from intestinal irradiation and a sinusitis which developed during convalescence.

She was discharged October 8 in good condition except for a residual marked anemia (hemoglobin 44 per cent). A Friedman test 3 months later in which a total of 30 cubic centimeters of urine were injected gave a negative reaction.

It is of some interest that although 24 hour specimens of urine were not employed, the Friedman tests of this patient, came within the limit mentioned by Mazer for a positive diagnosis of mole, since a positive reaction followed the injection of 0.06 cubic centimeter of urine.

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A LOWERED MORTALITY IN ACUTE APPENDICITIS AND THE BASIS THEREFOR¹

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REPORTS in the literature indicate that the mortality rate of acute appendicitis in its severer forms is not diminishing despite the accumulated experiences of several decades in the surgical treatment of the disease. In keeping with the results reported by others an analysis of the three year period 1928-1929-1930, on the surgical service of Mount Sinai Hospital to which we were attached discloses the data shown in Table I

TABLE I—DATA FOR 1928-1929, 1930

Type	Cases	Deaths	Mortality per cent
Acute phlegmonous or gangrenous	103	1	0.97
Acute, with abscess	23	7	30
Acute, with local peritonitis	9	—	—
Acute, with diffuse peritonitis	14	3	21.4
Total	149	11	7.4

In 1930 the problem of appendicitis was taken up anew from several angles: individualization of cases, indications for operation, operative technique, and general management. It was thought that careful consideration of these aspects might lead to some reduction of an obviously high mortality. The results for the second 3 year period are

TABLE II—DATA FOR 1931, 1932, 1933

Type	Cases	Deaths	Mortality per cent
Acute phlegmonous or gangrenous	1	0	0
Acute, with abscess	31	1	3.2
Acute, with local peritonitis	16	3	18.8
Acute, with diffuse peritonitis	—	—	—
Total	48	4	8.3

Some comments on classification and mortality should be made before the methods to which we ascribe the improvement in results are outlined. All cases in which operation was done in the 6 year period are included. The milder forms of acute appendicitis were eliminated because their inclusion tends to distort the true picture. Thus the addition of more than a hundred such cases without mortality would so lower the total figures for acute appendicitis that the results in the significant groups of cases might be glossed over. The classification of acute phlegmonous

(all layers involved) and acute gangrenous appendicitis (Group 1) is based on the operative findings and the pathological report. Some exudate was often present on the surface of the appendix in such cases. Clear or straw colored peritoneal fluid was not infrequently noted but was not classified as a local peritonitis. By the latter (Group 3) is meant considerable peritoneal exudate or free purulent fluid in the appendiceal region and (or) pelvis. The abscess group (Group 2) comprise an abscess or abscesses completely walled off from the peritoneal cavity by intestine and (or) omentum.

In the first 3 year period autopsies were performed in 8 of the 10 fatal cases in the first three groups. Suppuration was the cause of death in all. The clinical course indicated that infection was also the cause of death in the 3 cases with diffuse peritonitis. It has been shown elsewhere that suppuration is the most common cause of death after laparotomy for any infective intraperitoneal lesion.² Widespread local suppuration or diffuse peritonitis in the appendicitis abscess and local peritonitis groups were the essential lesions at autopsy. *A priori* it can be said that death from a spread of infection should not occur after operation for appendicitis abscess. There must be something fundamentally wrong in the high mortality of operation for appendicitis abscess insofar as the mortality is due to a peritonitis which did not exist at operation. To argue that such gross extension of infection might have occurred without operation is begging the question. The only logical conclusion is that it was induced by operation.

The two deaths in the abscess cases in the second 3 year series can be briefly discussed. In one a putrid lung abscess presumably due to aspiration developed, and the fulminating pulmonary lesion seemed to be the obvious

¹Neuhof, Harold, and Arnheim, Ernest H. The causes of death after operation. *Ann. Surg.* 1930, 92, 311.

cause of death. There was no autopsy. The second patient died 8 weeks after operation for appendicitis abscess. There had been considerable infection of the abdominal wall. A prolonged exhaustion psychosis appeared to be the cause of death. At autopsy there was no evidence of peritoneal infection.

Two deaths are not included in the tables of the second series. One patient was a child with diffuse peritonitis of a week's duration who was not operated upon and died a few hours after admission. The other patient was transferred to the surgical service with pylephlebitis and multiple abscesses of the liver as found at operation performed on admission. The removal of the causative appendiceal lesion did not influence the clinical course. Autopsy confirmed this statement.

DIAGNOSTIC FEATURES

A carefully obtained history has proved to us to be the most important factor in the diagnosis of acute appendicitis. The well known sequence of events is rarely lacking. If pain is localized its site is a suggestive lead to the situation of the lesion. Special palpation for a mass is an essential step because operation may be deferred under circumstances to be noted when a mass is felt. We have repeatedly observed that masses are much more readily discernible by gentle than by firm palpation. The rebound sign is not used, for we believe that it is unnecessary, may prove misleading, can excite undue pain and apprehension and may invite the spread of infection. Left sided abdominal puncture is performed when the diagnosis is in doubt and the patient is seriously ill. The procedure is of decisive aid in establishing the presence or absence of a peritonitis as well as the degree of the peritoneal infection. It is often practiced when the diagnosis of appendicitis appears certain in order to determine if diffuse peritoneal invasion is present or absent. The technique of and experiences with abdominal puncture have been reported elsewhere.¹ The subject is mentioned here because of its bearing on precision in diagnosis and therefore on plan for treatment. Whether or not a mass is

felt, an effort is made to determine the situation of the appendiceal lesion. As stated we accept localized pain as one lead. The site of localized tenderness, if present, is painstakingly sought for. A co-operative patient is asked to palpate his or her own abdomen to aid in determining the region of maximal tenderness. The abdomen is again palpated gently when the patient is anesthetized in order to determine if a mass can be felt. We stress the efforts at localization because the assumed site of the infected appendix is our guide for placing the abdominal incision.

PRE-OPERATIVE TREATMENT—THE CHOICE OF TIME FOR OPERATION

The correct choice of time for operation can be an important factor in the outcome of the case. We do not refer to patients in good condition with the symptoms and signs of an uncomplicated acute appendicitis. All patients with a short history (within 24 hours) are operated upon promptly. In many cases of 36 to 48 hours duration patients are also subjected to operation shortly after hospitalization. However in the second day phase and thereafter operation is not infrequently deferred for a time if the patient is not in good condition. The trip to the hospital may have been long and difficult; a patient may arrive in a highly excited state, another patient may be partially dehydrated. Examination may lead to the diagnosis of a localizing or localized infection. These are some of the factors which often lead us to wait a few hours or longer before proceeding with operation in the second or third day of an attack of acute appendicitis. The temperature and pulse rate usually drop with rest in bed. Dehydrated and shocked patients are placed on a slow intravenous drip of 5 per cent glucose in normal saline solution.

Young children and infants comprise a separate class because of the difficulties in determining the extent of the lesion and an apparently smaller likelihood of walling off of the infection. They are therefore operated upon without delay at any period, intravenous glucose solution being the only pre-operative therapy when the general condition is not satisfactory.

¹ Nishik, Harsh, and Cohen. In: Abdominal puncture in the diagnosis of acute intraperitoneal disease. *Ann. Surg.* 9:30, 1920, 424.

We rarely operate on appendicitis abscess as an urgent case. In fact immediate operation is contra indicated by us in most cases with well localized masses. These patients usually enter the hospital with considerable fever and rapid pulse. With rest in bed, light fluid diet, and intravenous glucose solution if necessary the fever subsides, the pulse rate slows down and the general condition improves. This has been our invariable experience in the past 3 years. Coincidentally spasticity becomes less evident, the mass less tender and more clearly defined. Operation is often deferred for several days and is usually performed when the temperature and pulse rate are approximately normal and the mass well circumscribed. We believe that the mortality of appendicitis abscess in the first series as high as the mortality of appendicitis with peritonitis is ascribable in part to the fact that operations were emergency procedures.

Critically ill patients with diffuse peritonitis are not operated upon directly after hospital admission. They are given absolute rest in bed, morphine and intravenous glucose in normal saline solution and are under continuous observation. Operation is usually performed several hours after admission at which time some and occasionally great improvement in the general condition is to be noted.

In all cases placed on pre-operative intravenous therapy the slow drip is continued throughout operation and is maintained for hours to days after operation depending on the condition of the patient.

ANÆSTHESIA

Avertin is administered to the great majority of cases; children included usually with the addition of nitrous oxide-oxygen and occasionally, ether. Postoperative nausea and vomiting are greatly reduced thereby and abdominal distention is less apt to occur than with nitrous-oxide ether anaesthesia. Spinal anaesthesia is reserved for obese patients who are not gravely ill. We believe that the shock which results occasionally from spinal anaesthesia lowers general resistance to infection and in that sense invites spread of infection.

OPERATION

We are fundamentally opposed to the concept of a procedure to be done with great celerity through a small incision, or with tactile location and finger delivery of the appendix. Many patients will of course recover after a technique quite out of line with the niceties of operative procedures customarily practiced in abdominal surgery. We are convinced, however, that spread of infection is a not infrequent sequel which can be avoided with a careful and deliberate technique. Conceding the occasional necessity for speed of operation, we are of the opinion that the great majority of patients will have a better chance for survival with a carefully executed operation performed under adequate visualization. As already shown the most common cause of death after operation is intraperitoneal suppuration and not a complication at some distant place.

INCISION

The incision should be large enough for full visualization of the lesion. The type and placement of the incision depend on the location or assumed location of the appendiceal lesion. The majority of our patients have been operated upon through a rectus splitting incision. If a McBurney incision is employed we sever the muscles when better exposure is required. A vertical incision through all layers lateral to the rectus is practiced for a laterally situated appendix. Whenever a mass is felt, the incision is placed directly over it. A routine incision which disregards the situation of the lesion is illogical. It may open the peritoneal space for more than the required extent, may make access to the appendix more difficult and for these reasons may lead to spread of infection. The incision should always be enlarged in the desired direction for adequate exposure, rather than to apply vigorous retraction for the purpose.

INTRAPERITONEAL PROCEDURES

Suction is at hand and is employed for the removal of infected fluid in the operative field. As soon as the cæcum is identified and isolated the peritoneal cavity is shut off with moist pads or packings. Whenever feasible

the omentum is drawn down and spread over loops of gut before the pads are placed in position. Other than the terminal ileum no small intestine is to be seen in the field until the time for closure of the abdominal incision. The base of the appendix is identified by following the anterior longitudinal band of the cecum. A ligature is passed through the meso-appendix at this point the cecum is packed away and gentle traction is made on the ligature. The appendix is then delivered from base to tip by placing Allis forceps about it, under inspection. If the appendix is adherent it should be freed by instrumental dissection. Handling of the infected organ is not necessary in the majority of cases. If palpation is required to determine the position of the appendix or if manual delivery of the appendix must be performed the contaminated glove is at once discarded. There should be no contact between the appendix and adjacent pads or retractors during its delivery under full vision. The cecum is not packed away but is held out of the wound to facilitate the delivery of a deeply placed appendix. When a mass is present an abscess is assumed to exist. The instrument for its entry (bone elevator or curved scissors) is held in one hand and the suction tip in the other so that pus is sucked up as soon as pus is encountered. The correct plane of cleavage in abscess cases is carefully sought for and maintained under inspection. A sterile light is useful for this purpose and can at the same time be employed as a retractor. Abscess cavity or cavities are explored to their limits in order to be sure that unopened pockets are not left behind. The appendix is usually but not invariably removed.

DRAINAGE

Strips of Iodoform gauze of varying width, depending on the individual requirements, are used. In abscess cases they are packed into all recesses of the cavity or cavities. Packing by gauze is employed in non-abscess cases if appreciable purulent exudate about the appendix exists or when the appendix has been attached to an obviously infected bed. In our opinion drainage is particularly indicated in such cases when the infected area is behind

the cecum against the posterior parietal peritoneum.

Drainage by tubes is not employed. We consider tube drainage not only illogical but also an invitation to maintenance and spread of infection for the following reasons: (1) no assurance that the tube remains where it is placed. (2) Irregular collapse of walls of abscess cavity or infected bed around and beyond the tube with consequent tendency towards pocketing. (3) the postmortem evidence of residual abscesses about tube drains. (4) the commonly noted postoperative foul discharge and sloughing with tube drainage. We regard perfunctory gauze drainage as unsatisfactory as drainage by tubes. Gauze drainage is only correct if the infected area or areas are packed open widely from the bottom.

Contaminated instruments, and gloves if contaminated are discarded after the gauze pack is placed. Rubber dam is used to separate the gauze from intestines, and omentum is drawn alongside whenever feasible. The abdominal wall is closed in layers but not tightly about the drains.

POSTOPERATIVE TREATMENT

Drains are not disturbed until loosened by discharge. Their gradual shortening is usually begun about a week after operation. Discharge is rarely profuse and never foul. Infection of the abdominal wall is also rare. When the packing is removed, a clean bed is usually seen. Light repacking is not infrequently desirable in order to prevent premature closure.

As already stated the intravenous drip started before or during operation in the more serious cases, is maintained after operation until the general condition is satisfactory. We believe that a number of our cases have recovered as the result of the continuous intravenous administration of glucose saline solution. When kept up for days the needle is shifted from vein to vein in order to minimize the chances of phlebitis. Commonly employed procedures such as the indwelling Levin tube and colonic irrigations require no discussion. In our opinion rest is imperative for sick patients and we do not hesitate to administer adequate amounts of opiates for that purpose. Cathartics are never admin-

istered until the patient is convalescent and are rarely given at any time. Manifestations of intestinal obstruction are assumed to be due to angulation of bowel by fibrinous exudate which is likely to absorb. The occasional cases in which intestinal obstruction has developed in the early postoperative period have therefore not been subjected to operation and all have spontaneously recovered.

Regardless of physical signs suggesting a pulmonary or some other distant postoperative complication we assume that a patient who is not doing well after operation is suffering from infection related to the operative field. Close watching for evidence of suppuration is therefore begun under such circumstances. The status of the general peritoneal cavity can be almost certainly established by left sided abdominal puncture if there is the slightest doubt as to the existence of peritonitis. The timely drainage of a subphrenic abscess, an encapsulated intraperitoneal collection of pus or a retroperitoneal phlegmon may prove to be the vital factor in the recovery of the patient.

SUMMARY

Intraperitoneal suppuration and not some distant complication is the usual cause of death after operation for acute appendicitis.

Death should occur only rarely after operation for acute phlegmonous appendicitis, appendicitis with local peritonitis or appendicitis with abscess, unless diffuse peritonitis also exists at the time of operation.

A comparison of the mortality of the severer forms of acute appendicitis on one surgical service in two successive 3 year periods shows a marked reduction in the second period except in the category of diffuse peritonitis.

The factors contributing in varying degree to the lowered mortality are discussed under several headings: diagnostic features, preoperative treatment, the choice of time for operation with special reference to appendicitis abscess, anaesthesia, general principles of operation, choice of incision, carefully executed operation under full visualization with minimal soiling, gauze drainage, postoperative management, the search for, and timely drainage of complicating suppurative foci.

CLINICAL SURGERY

FROM THE DEPARTMENT OF SURGERY UNIVERSITY OF NEBRASKA

ABDOMINAL INCISION IN LESIONS OF THE RECTUM AND RECTOSIGMOID AS RELATED TO THE COLOSTOMY

R. RUSSELL BEST, M.D., F.A.C.S. OMAHA, NEBRASKA

THE statement by Moynihan that circumstances connected with the incision are now among the most important in the whole range of abdominal surgery I believe was no exaggeration. In the election of an initial abdominal incision in cases of carcinoma involving the rectum and rectosigmoid, a more complicated set of purposes arises than in questions dealing with the average colostomy. In most instances and at the hands of the majority of operators, a two-stage procedure is preferable in carcinoma of this area, and not infrequently an abdominal incision is made in both stages. There are two essentials demanded—first a correctly placed incision, ample enough to carry out thorough exploration, both palpatory and visual, and to permit any necessary intra-abdominal procedure; second the carrying out of a properly placed colostomy, either loop or end type and either temporary or permanent. It seems to be the consensus of opinion that a median or paramedian incision offers the operator the better opportunities. I prefer the paramedian incision because I believe it is fairly well established that muscle-to-muscle and fascia-to-fascia apposition gives better support to the wound, and where a colostomy is implicated complete surrounding of the limb or limbs of colon by muscle tissue provides a better functioning colonic aperture. As a matter of fact probably all abdominal work could be done with two incisions, namely, the right and left paramedian incisions.

As to the considerations against the lower left paramedian incision it is commonly believed that herniation is more liable to follow a rectus incision than a left McBurney or muscle splitting incision; that the re-opening of a potentially infected wound at the second stage of an operation may introduce infection into the peritoneal cavity, and if the wound does heal there is the possibility of a weak abdominal wall. As to the first considered and

verily, I have found that herniation very rarely occurs at the site of a left rectus incision if the abdominal wall is correctly and securely closed. The following technique has been used in my cases. When surgery of the large bowel is involved with or without colostomy the peritoneum is closed by a continuous chromic catgut suture. If a limb of bowel is brought out through the wound separate sutures are entered above and below the protruding viscus. These should be brought fairly snug around the ends of the loop of bowel. The first tier of sutures, continuous in type, securely closes the peritoneal cavity and holds the peritoneum and overlying transversalis fascia in apposition. The second tier bringing together muscle and fascia is of interrupted chromic catgut sutures, placed about 1 centimeter apart. There is greater strain upon the more superficial muscle and fascia layers and if a continuous suture is used the entire length of the wound is threatened should the suture break. With interrupted sutures in these layers, this hazard is not so great even in the face of infection. The skin is closed with interrupted dermal sutures, with or without the additional support of silk-worm figure-of-eight retention sutures. I am beginning to doubt the necessity of these latter sutures if the wound is closed as heretofore described and have omitted them on many occasions. This type of wound closure is used at both stages of the operation. Following this technique in a series of seventy-five colostomy cases, I have had no instance of true herniation develop and only on one occasion have I detected even a slight weakness in the abdominal wall.

In opening the left rectus incision at the second stage of the operation, I have found that gross infection of the wound is quite rare if proper pre-operative management and colon surgery technique have been followed. These wounds seem to heal in spite of their constant

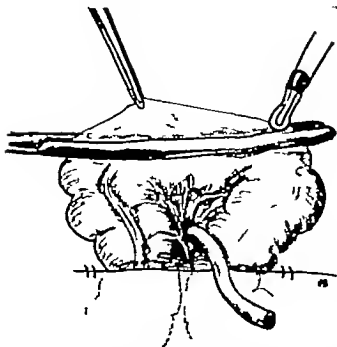


Fig. 1. Temporary colostomy through left rectus. Application of crushing clamps in longitudinal direction and excision of the tissue with cautery. Bowel drainage permitted by release of clamps, thus requiring no further use of cautery.

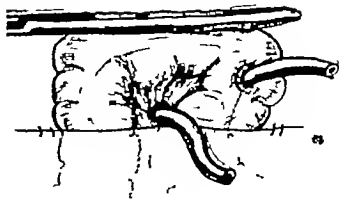


Fig. 2. The tissue beyond the clamp has been excised with the cautery and release of the clamps establishes the temporary colostomy through the left rectus. If immediate drainage of the proximal loop is imperative, a small catheter is pursestrung into this loop.

contact with feces, particularly if the feces are not permitted to neighborhood the wound during the first 12 to 24 hours. If infection does occur, the time elapsing between the first and second stages of the operation usually permits proper recovery of the tissues and establishes an immunity. An abdominal wall is probably stronger after two incisions through the same area with proper suturing than after two incisions so close proximity either properly or improperly sutured.

The following types of incisions are usually elected by the various surgeons. Lahey and his colleagues use the median incision between the pubis and umbilicus and bring out the proximal end of the sigmoid through a very small left McBurney incision. The distal end is implanted in the lower angle of the median incision. This permits thorough through-and-through irrigation of the diseased segment, a point which I think is a marked advance in technique and which I personally follow. At the second stage of the procedure, the median incision is re-opened. Just what procedure this author follows in the inoperable case is not stated in this noteworthy contribution. Rankin prefers a low median incision and inguinal colostomy, although the distal segment is dropped back into the abdomen. He re-opens this incision at the second stage. The technique of the inoperable case is not described. Coffey uses a right rectus incision and pulls the

proximal end out through a left rectus incision. By his technique, the second stage is entirely a perineal operation. C. H. Mayo describes a left muscle splitting incision parallel with Poupart's ligament ample enough for palpatory exploration. The layers of the abdominal wall are brought out under the loop. At the second stage, a midline incision is probably used although this is not definitely stated. I doubt if this primary incision gives one quite the freedom for exploration and vision into the abdomen that the midline or paramedian incision does. Also in this technique the cautery is used later to open the colostomy rather than merely releasing the clamps. However both colostomy limbs are completely surrounded by muscle which I believe is essential in a properly functioning colostomy. Regarding the advantages of the left rectus incision there is greater ease of exploration, both palpatory and visual. The left lumbar gutter may be closed off by a pursestrung suture without difficulty. A good functioning colostomy either between the fibers of the left rectus or through an accessory small McBurney's incision may be made and in either instance will be completely encircled with intact muscle fibers, which is so important in the permanent colostomy whether in an operable or inoperable case. Any type of lesion, under any or all circumstances may be adequately dealt with.

Now let us consider the various possibilities of a clinical nature which may present themselves. In acute obstruction of the colon within the sigmoid or rectum, the left rectus incision affords an ample opening and, if exploratory, is not contra-indicated. It may be carried out with ease. If a temporary type of colostomy is indicated, a

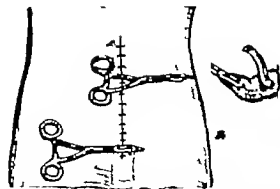


Fig. 3 If case is operable the method of Lahey is followed. The proximal segment is brought out through the small left McBurney incision and clamped left on. The distal loop is clamped at the lower margin of the left rectus incision. If immediate drainage is necessary a small catheter is perstringed into the proximal stump as shown in the insert.

loop of sigmoid may be brought out over a glass rod through this incision after the left lumbar gutter is closed off. To avoid subjecting the patient a few days later to the repugnance of the odor of his own burning flesh, and perhaps the application of clamps to bleeding points with its attending distress, I usually follow a suggestion of Hirschman, except that I go a step farther. Hirschman suggests in his paper "Median Colostomy (Umbilical)" grasping a longitudinal

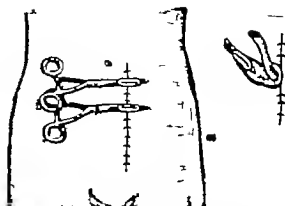


Fig. 4 If the case is inoperable, the loop of sigmoid is brought out through the left rectus incision, bridge of all layers of abdominal wall is brought through a rent in the mesocolon and sutured. The remainder of the wound is then closed and the sigmoid severed between two clamps, thus establishing a good end type of permanent colostomy. This method is also used in operable cases of colostomy and posterior resection. If immediate drainage is necessary a small catheter is perstringed into the proximal stump as shown in the insert.

band by two forceps about 2 to 3 inches apart, raising upward, and then applying a long curved clamp just below the ends of the traction forceps. The clamping of the forceps puts pressure on a spindle shaped area which becomes the opening of the colostomy when the clamp is later removed. Of late, in a number of cases, I have applied the clamp and then with cautery destroyed the bowel tissue beyond the margin of the clamp. If it is then necessary to open the clamp in a few hours, the opening is already present. If immediate drainage of the bowel is necessary a catheter may be perstringed into the loop of sigmoid and immediate drainage established, followed later by the removal of the clamp for the regular colostomy opening. Following this technique, whether the case is operable or inoperable, and whether permanent or temporary colostomy is necessary, there is no necessity for the patient to experience the minimal odor of his own burning flesh and the distress and discomfort that usually accompany the grasping of bleeding points along the mesenteric border.

If the case is considered operable and one follows the technique of Lahey for abdominoperineal resection, this incision is also most serviceable. If immediate drainage of the bowel is necessary a catheter may be inserted just proximal to the clamp and held in place with a perstringing suture (Fig. 3).

If the case is operable and colostomy and posterior resection is the operation of choice, the

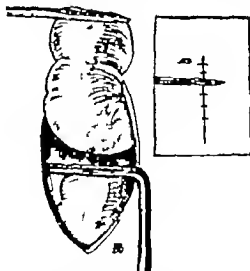


Fig. 5 If an anterior resection is ad nable, the distal stump is securely closed and the proximal limb is brought out through the upper angle of the left rectus incision and colostomy established. A catheter may be perstringed into the side of this stump if necessary.

following technique is used. After ligation of a few blood vessels in the mesentery of the sigmoid to permit a rent of sufficient size, the left lumbar gutter is closed. Holding the loop of sigmoid upward, a tongue of peritoneum is brought beneath the loop and secured to the opposite peritoneal wall. Likewise a layer of muscle and fascia is brought beneath the loop and secured by a mattress chromic catgut suture. Finally the skin is brought beneath the loop and secured with a mattress suture of dermo. The peritoneal edges at the upper angle of the wound are brought together with a continuous chromic catgut suture, as are those at the lower angle of the wound. The muscle and fascia are approximated with interrupted chromic catgut sutures placed about 1 centimeter apart. The closure around the limbs of bowel should be rather snug to permit early sealing off of the peritoneal cavity. The skin is closed with interrupted dermo sutures. Two crushing clamps are applied close together and the bowel severed with the cautery (Fig. 4). The clamps are left on and strapped to the abdominal wall. The clamps are released 48 to 72 hours later. If immediate drainage of the bowel is necessary, a small catheter may be inserted into the lumen of the bowel just proximal to the proximal clamp, using a pursestring suture to prevent contamination.

In cases in which the lesion is so advanced as to be inoperable, the technique for colostomy is the same as that just described for colostomy and posterior resection. This gives a good functioning end-type of colostomy in this group of individuals in whom the minutest details for comfort are most necessary and deserved. Bowel contents do not pass over from the upper stoma into the lower diseased segment and cleansing irrigation of the lower segment is easily carried out.

If anterior resection of the sigmoid is feasible this incision permits adequate exposure and the intermuscular end type of colostomy may be established at the upper angle of the wound (Fig. 5).

With this time honored incision, both emergency and selective operations are adequately handled and desirable types of colostomies may be placed in both operable and inoperable cases. If a permanent colostomy is necessary in either case, the end type of colostomy well encircled with muscle is easily carried out. In no instance is it necessary to use the cautery after the patient has left the operating room. In the inoperable case greater comfort is given the patient by permitting through and through irrigation of the diseased distal segment. In the inoperable case in which colostomy carries a material increase in mortality, one is able to give the patient an end type of colostomy completely surrounded by muscle and there is no fear of spreading infection into the peritoneal cavity since the bowel continuity is not severed until the abdomen has been completely closed. Drainage of the proximal limb may be instituted immediately with very little danger of contamination.

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PEPTIC ULCER OF MECKEL'S DIVERTICULUM

A REPORT OF TWO CASES AND A REVIEW OF THE LITERATURE¹

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MECKEL'S diverticulum, which represents a remnant of the intestinal end of the omphalomesenteric duct, occurs in 1 to 3 per cent of the human race and is more common in the male sex. The mucosa membrane of the diverticulum, usually of the ileac type, may also be of gastric and less often of duodenal, jejunal, or pancreatic character. When present, the gastric mucosa generally lines the greater portion of the diverticulum and may include both fundus and pyloric glands. Schaetz in a study of 37 specimens of Meckel's diverticulum found gastric mucosa present in 16.6 per cent, duodenal or jejunal mucosa in 10 per cent, pancreatic tissue in 2.7 per cent, and both pancreatic and gastric tissue in 5.4 per cent. Koch states that gastric mucosa was present in 12 per cent of the specimens which he examined. Hudson and Koplik report the presence of gastric mucosa in 52 per cent of 23 specimens studied microscopically. In a subsequent article by Hudson, in which 13 cases of Meckel's diverticulum are reported, gastric mucosa was present in 7 cases and duodenal mucosa in 1 case. In our review of the literature we have found 46 cases of typical peptic ulcer substantiated by histological examination, which with the addition of our 2 cases, makes a total of 48 cases (Table I). In this group 44 specimens contained gastric mucosa, 2 specimens both gastric mucosa and pancreatic tissue, 1 specimen pancreatic tissue, and 1 specimen duodenal mucosa. It is interesting to know that in umbilical cysts or fistulas, which represent remnants of the umbilical end of the omphalomesenteric duct, gastric mucosa may also be found. Achsner and Karelitz have collected 9 reports from the years 1881 to 1908 of tumors, cysts, or fistulas of the umbilicus secreting an acid fluid, which structures when removed and examined presented in whole or in part the histology of gastric mucosa. Lindau and Wulff have reported a case of an umbilical pouch lined by gastric mucosa containing a chronic peptic ulcer.

The clinical picture of peptic ulceration of Meckel's diverticulum is comparatively new. Deetz, in 1907 reported a case of acute perforation at the base of a Meckel's diverticulum in a boy 9 years of age. The diverticulum was amputated distal to the site of perforation, and microscopically

it showed gastric and pancreatic tissue. He suggested that the process which resulted in perforation might be similar to that occurring in gastric ulcer. Huebschmann, in 1913 reported the case of a boy 4½ years old who had intestinal hemorrhages after abdominal trauma. One month later he developed peritonitis and died after operation. At autopsy a perforated marginal ulcer was found at the edge of gastric mucosa. Because of the absence of inflammatory signs he did not think that the perforation was the result of a diverticulitis. Callender in 1915 described the autopsy of an infant 19 months of age which had died from intestinal hemorrhage. A diverticulum 2.5 centimeters long was found with a punched-out regular ulcer eroding an artery at the junction of gastric and ileac mucous membranes. In the same year Gramen reported a case in a 20 year old boy who suddenly developed peritonitis and was found at operation to have a perforated ulcer of Meckel's diverticulum located at the edge of gastric mucosa. In 1924 R. H. Jackson reported a case of a 10 year old boy who was operated upon in 1912 because of repeated intestinal hemorrhages. An eroded vessel was noticed in a marginal ulcer at the base of Meckel's diverticulum. It was not subjected to histological examination and it was suggested that it might be tuberculous. This case was unquestionably one of peptic ulcer. In 1925 Stula and Wosinger reported 2 cases of their own and 11 cases which they had collected from the literature. They described very accurately the clinical syndrome accompanying this pathological condition. Abt and Strauss, in 1926 reported 3 cases and called attention to the syndrome described by the writers just mentioned. The greater number of cases have been reported since 1920. Since 1930 reviews have been published by Achsner and Karelitz, Lindau and Wulff, and Mason and Graham. In 1932 Vaughn and Singer described comprehensively the perforative type of peptic ulcer.

The two following cases of our own represent two contrasting examples. The first case presents the more typical clinical picture of recurring massive hemorrhage from the bowel without other specific symptoms or physical signs while the second case chronologically our first case, illustrates the more infrequent circumstance of acute

¹The two cases reported in this article are reported separately by Dr. Renner as a brief paper which he read before the Section of Pediatrics and Obstetrics of the Ohio State Medical Association, at the meeting at Akron, Ohio, September 7, 1933.

TABLE I.—DEFINITE PEPTIC ULCER CASES WHICH HAVE BEEN CONFIRMED MICROSCOPICALLY

A. Case	Year	Age	Sex	Diagnosis		Pre-operative diagnosis	Gross findings	Histological findings	Result	Remarks
				Intestinal ulcer	Acute ulcer					
1. Davis (4)	1907	9	M	+	+	Perforated appendix	Perforated ulcer 1 base Peritonitis	Gastric and pancreatic mucosa	Recovered	First definite clinical case
2. Hirschman (12)	1912	44	M	+	+	Peritonitis	Perforated marginal ulcer Peritonitis	Ulcer at edge of gastric mucosa	Died	
3. Callender (6)	1915	19 mo		+		Autopsy Death of lumbar abscess	Perforated ulcer at base of mesentery	Gastric and ileal mucosa	Died	
4. Graham (15)	1915	0	M	+	+	Appendicitis	Perforated ulcer Peritonitis	Ulcer at edge of gastric mucosa	Recovered	
5. Macgregor (20)	1918	13	M	+	+	Autopsy Death of ulcer cancer	Ulcer about to perforate	Ulcer at edge of gastric mucosa	Died	
6. Macfar (23)	1919	11	M	+	+	Peritonitis	Perforated ulcer	Ulcer at edge of gastric mucosa	Recovered	
7. McCreesh and Dewart (24)	1921	26	M	+	+	Duodenal or intestinal ulcer	Ulcer at base	Ulcer at junction of gastric and ileal mucosa	Recovered	
8. Schroeder (16)	1921	8	M	+	+	Duodenal ulcer (X-ray)	Thickened 30 mm. Ulcer base of diverticulum. Eroded vessel	Pancreatic lesion at tip	Recovered	Bleeding small intestine
9. Brewer (25)	1924	15	M	+	+	Tumor or polyp Autopsy	Perforated ulcer at base Peritonitis	Ulcer at junction of gastric and ileal mucosa	Died	Perforated 3 days after operation for tumor on polyp
10. O'Neil (14)	1924	14	M		+	Intestinal tuberculosis	Chronic penetrating marginal ulcer Eroded vessel	Ulcer at junction of gastric and ileal mucosa	Recovered	
11. Hunsbert (18)	1924	15 mo	M	+	+	Peritonitis	Perforated ulcer Peritonitis	Ulcer at junction of gastric and ileal mucosa	Died	
12. Parake (47)	1925	41	M	+	+	Ulcer cancer	Ulcer of Meckel's diverticulum	Peptic character confirmed	Recovered	
13. Welch (37)	1925	8 mo	M	+	+	Peritonitis	Perforated ulcer Peritonitis. Blood in peritoneal cavity	Bleeding ulcer at base. Gastric mucosa present	Died	Perforated under observation
14. Alvi and Strum (Case 1)	1926	3	F	+	+	?	Ulcerated and inflamed diverticulum	Gastric mucosa at apex. Inflamed and fibrotic like atrophic peptic ulcer	Recovered	
15. Eickberg (17)	1926	76	M	+	+	Appendicitis with perforation	Perforating ulcer partially healed	Gastric mucosa distal to ulcer	Recovered	
16. Kierstead (22)	1927	13	M	+	+	Appendicitis	Perforation at base. Peritonitis	Gastric mucosa present	Recovered	Perforated under observation
17. McCull (26)	1927	4	M	+	+	Autopsy	Perforation at base Abscess in abdominal wall Peritonitis	Ulcer at junction of gastric and ileal mucosa	Died	Perforated under observation
18. Jackson, A. S. (28)	1927	14	M	+	+	Ulcer of Meckel's diverticulum	No gross ulcer	Gastric mucosa and area of ulceration	Recovered	

TABLE I.—DEFINITE PEPTIC ULCER CASES WHICH HAVE BEEN CONFIRMED MICROSCOPICALLY—Continued

Author	Year	Age	Sex	Symptoms		Pre-operative diagnosis	Gross findings	Histological findings	Result	Remarks
				Inter- mittent Pain	Acute epigastric attack					
19 Taylor (44)	1917	21	M	+		Atrophy. Death of lower esophagus	Interspersed layers with varying chronic ulcer ulcer	Ulcer bordering area of gastric mucosa	Dead	
20 Means (45)	1918		M	+		Lactumagitation of peptid	Chronic ulcer at tip perforating the lesser of a higher level. Large Pyl at blood	Gastric and duodenal mucosa	Recovered	
21 Hershman (46)	1918	24	F	+	+	Perforated appendix	Perforated ulcer at base Perforation	Ulcer at junction of gastric and duodenal mucosa	Recovered	
22 Peterson and Singer (47)	1918	6	M	+	+	Ulcer of Meckel's diverticulum	Perforated chronic ulcer ulcer at tip perforating the lesser of a higher level, but two ulcer ulcers	Gastric mucosa present	Recovered	At first operation only blood was present in perforated ulcer
23 Trophim (48)	1919	Child			+	Appendicitis. Appendectomy. Second operation for recurrent pain	Dilated cecum containing peptid. Peptid ulcer at neck, ulcer of Meckel's diverticulum	Ulcer at base section. Mucosa of gastric mucosa	Recovered	
24 Franklin (49)	1919				+	Perforation	Acute perforation at base Perforation	Ulcer in base junction. Co of diverticulum found with gastric mucosa	Dead	
25 Waldman (50)	1919		M	+	+	Intussusception	Isolated, calcified Meckel's diverticulum	Shallow ulcer ulcer ulcer of gastric mucosa	Recovered	
26 Schmidt (51)	1920	28	M		+	Perforation	Two chronic ulcers at neck, ulcer perforated	Ulcer at junction of gastric and duodenal mucosa	Recovered	
27 Adams and Kierulff (52)	1920	27	F	+		Ulcer of Meckel's diverticulum	Perforating marginal ulcer Meckel's diverticulum	Ulcer at base section at edge of gastric mucosa	Recovered	
28 Achauer and Kierulff (53)	1920		M	+	+	Lactumagitation	Peptid ulcer at base	Ulcer at junction of gastric and duodenal mucosa	Recovered	
29 Ferris, Pyle, and Lippert (54)	1920	7	M	+	+	Perforated appendix	Perforated ulcer at base Perforation	Chronic ulcer. Duodenal mucosa present	Recovered	
30 Ferris, Pyle, and Lippert (55)	1920	8	M	+	+	Lactumagitation	Perforated ulcer at base Perforation	Ulcer at junction of gastric and duodenal mucosa	Recovered	
31 Hahner (56)	1920	3	M	+	+	Perforative appendix ulcer	Perforated ulcer with local abscess	Ulcer at junction of gastric and duodenal mucosa	Recovered	Operated upon as a diverticulum for peptid
32 Hahner (57)	1920		M	+		Blindling duodenal ulcer	Two duodenal ulcers. Blinding ulcer of Meckel's diverticulum	Gastric mucosa present	Recovered	
33 Cobb (58)	1921	25	M	+	+	Acute appendicitis	Perforated, perforated, ulcer ulcer ulcer ulcer	Ulcer at junction of gastric and duodenal mucosa	Recovered	
34 Treves and O'Connell (59)	1921	29	F	+		Perforation ulcer of Meckel's diverticulum	Small round ulcer at base	Gastric mucosa distal to ulcer	Recovered	Pre-operative X-ray series suggestive

TABLE I.—DEFINITE PEPTIC ULCER CASES WHICH HAVE BEEN CONFIRMED MICROSCOPICALLY—Continued

Author	Year	Age	Sex	Seropositive			Pre-operative diagnosis	Gross findings	Histological findings	Result	Remarks
				Free	Post	Intra- oper- ative ab- sence					
32. Lindner and Wolff (46)	1931	15	M	+	+	+	Peritonitis	Perforated ulcer found at autopsy	Chronic perforating ulcer ad- herent to gastric antrum	Dead	
33. Greenwald and Kramer (77)	1932	15 wk.	M	+	+	+	Perforated ulcer of Meckel's diverticulum	Perforated perforation near base	Area of gastric mucosa	Dead	X-ray examination also showed air below the di- aphragm
34. Bruchow (5)	1932	8	F	+	+			Chronic ulcer at neck of diver- ticulum	Gastric mucosa present	Recovered	
35. Hudson and Koplik (12) (Case 14)	1933	6	M	+	+	+	Peritonitis	Perforated ulcer	Ulcer at junction of gastric and ileal mucosa	Dead	Perforated under observation
36. Hudson and Koplik (12) (Case 31)	1933	6½	M	+	+	+		Superficial ulcer of blood infarction	Inflammation and superficial ulceration. Gastric and ileal mucosa	Recovered	
37. Vignia and Kugel (58)	1934	7	M	+	+	+	Acute appendicitis	Walled-off acute perforation	Ulcer at junction of gastric and ileal mucosa	Recovered	
38. Mason and Graham (37)	1935	9 mos.	M	+	+	+		Meckel's diverticulum 6 cm. long	Chronic ulcer at junction of gastric and ileal mucosa. Fasciatic tissue at top	Recovered	
39. Rowell and Merry (41)	1935	7	M	+	+	+	Peritonitis—apudochal	Adherent mass. Local shaped perforation at base	Gastric mucosa present	Dead	
40. Wolff (60)	1935	10	F	+	+	+		Chronic perforate ulcer at base	Gastric mucosa present	Recovered	
41. Hudson (42) (Case 1)	1935	11	M	+	+	+	Not given	Blood-filled diverticulum. Filled in small intestine	Acute ulcer at junction of gas- tric and ileal mucosa	Dead	
42. Hudson (42) (Case 2)	1935	9 mos.	M	+	+	+	Peritonitis	Perforation and inflammation of diverticulum. Peritoneal blood in peritoneal cavity	Gastric mucosa present	Dead	
43. Dringstedt (70)	1935	17	M	+	+	+	Ulcer of small intestine or cecum	Chronic perforating ulcer	Diverticulum lined with gastric mucosa	Recovered	
44. Johnston and Renner	1935	16 mo.	M	+	+	+	Acute appendicitis	Acute localized perforation at base, sealed against adhe- sion wall	Ulcer at junction of gastric and ileal mucosa	Recovered	
45. Johnston and Renner	1935	18 mo.	F	+	+	+	Ulcer of Meckel's diver- ticulum	Superficial ulcer at base	Superficial shallow ulcer at junc- tion of gastric and ileal mu- cosa	Recovered	

*Reported in this article.

perforation and an acute surgical abdomen as the initial symptom of the condition.

CASE. The patient was a female infant 15 months of age. She had been a full term infant of normal delivery. Except for jaundice the first week and some feeding difficulties during the first months of life she was well until the age of 9 months when she passed a stool which was full of blood, following which she was so weak and pallid that she was taken to a hospital in another city where she remained 8 days. She recovered from her anemia, and 3 months later she developed pneumonia, after which she was well up to the time of her present illness.

On July 3, 1931 at the age of 3 months, suddenly without pain or colic, she passed a stool containing a large amount of red blood. She passed a similar stool that evening. There were no other symptoms. On the morning of the second day she passed blood again, which this time gave the stool a very dark red color almost a tarry appearance. This stool was saved for examination and it contained about 3 ounces of clotted blood. One of us (G.R.) was at this time asked to see her and after a preliminary examination he sent her to the Good Samaritan Hospital with a provisional diagnosis of ulceration of Meckel's diverticulum.

Examination revealed a well nourished infant, exceedingly pale, but without any other signs of acute illness. The pallor was the only positive finding. The abdomen was negative. Rectal examination revealed no polyps. The temperature was 100 degrees, the red blood cell count, 3,500,000 the white blood cell count, 5,000, the hemoglobin 35 per cent and the bleeding time and clotting time were within normal limits. An immediate blood transfusion, and a second transfusion 6 days later raised the hemoglobin to 50 per cent. A roentgenological examination of the gastro-intestinal tract was negative. Eight days after admission, a laparotomy was performed with a pre-operative diagnosis of peptic ulcer of Meckel's diverticulum.

At operation a diverticulum 1 inch long was found on the ileum about 14 inches above the cecum. Its peritoneal surface appeared normal. The diverticulum was excised with a narrow cuff of intestinal wall, and an appendectomy was also done. The infant's convalescence was uneventful. Examination of the diverticulum revealed a small clean-cut superficial ulcer about 5 millimeters in diameter located at the base of the diverticulum and extending into the intestinal mucosa. Microscopic examination revealed the ulcer located at the junction of gastric and ileal mucous membranes. The entire mucous membrane of the diverticulum was of gastric character that in the proximal half resembling pyloric glands, and that in the distal half fundic glands with chief and parietal cells. The floor of the ulcer was covered with thin eschar and the wall of the diverticulum in this region showed some evidence of chronic inflammation.

CASE 2. The patient was a healthy well nourished male infant 8 months of age, with no history of previous illness. The night before admission to the Good Samaritan Hospital he awoke with intense abdominal pain. After crying for 3 hours he went to sleep. The following morning, January 18, 1932 he vomited twice and appeared to have abdominal discomfort. One of us (G.R.) was then called and after an examination he sent the child to the hospital with a diagnosis of acute appendicitis.

The temperature was 100.6 degrees, pulse, 144, and respiration, 23. The patient appeared depressed and the thighs were drawn up. The abdomen was of normal contour. In the lower right quadrant there was definite local tenderness and moderate muscle spasm. Rectal examination was negative. The white blood cell count was 12,700

with 65 per cent polymorphonuclear leucocytes. An immediate operation was decided upon.

Operation revealed some slightly turbid, straw-colored peritoneal fluid. On insertion of the forefinger a small mass was felt which had so recently adhered to the anterior abdominal wall that it was freed at the first touch and presented into the wound. This mass was a Meckel's diverticulum 1 inch long, located on the lower ileum about 18 inches from the ileocecal junction. At its base was a punched-out, lenticular perforation, which had adhered to the abdominal wall promptly enough to prevent a frank peritonitis. The comment was made by the operator (J. B. J.) that the perforation resembled the acute perforations seen at or near the pylorus. The diverticulum was excised with a narrow cuff of intestinal wall, and an appendectomy was also done. The patient recovered promptly. Subsequent pathological examination revealed that the mucosa of the diverticulum was definitely of gastric character and the fundus-like glands contained chief and parietal cells. The acute perforation was located in a small chronic ulcer at the junction of gastric and ileal mucous membranes. The fibrotic thickening of the wall in the region of the ulcer indicated that it was chronic one.

We have found in the literature a total of 78 cases which we have grouped as follows (see Tables I, II, and III). Group I includes 48 cases of definite ulcer in which gastric, duodenal, or pancreatic mucosa was definitely demonstrated. Group II includes 14 cases which in clinical and gross pathological findings quite definitely belong in the peptic ulcer group but which were not examined histologically. In Group III are 16 cases, some with and others without gastric mucosa, all lacking demonstrated ulcers except 3 cases reported by Stern as phlegmonous perforations. It is quite probable that most of these cases belong in the peptic ulcer group but we have not included them in the compilation of our statistics.

There is usually a single ulcer, found commonly in a short diverticulum. With few exceptions the ulcer has been located at the base of the diverticulum at the junction of gastric and ileal mucous membranes, and extending into the ileal rather than into the gastric mucosa. In some instances the ulcer at the base has been termed an *ileal* ulcer but the term *marginal* is used most frequently and is more descriptive because the ileal mucosa generally extends for a short distance into the base of the diverticulum. Occasionally multiple ulcers are seen as in the cases of Moll, Schmidt, and Peterman and Seeger. In the cases of Taylor and Peterman and Seeger definite ileal ulcers were described. In the latter case and also the case of Meiss an ulcer at tip of diverticulum had perforated the ileum at a higher level. The chronic type of ulcer is usually found, typical cases of which are those of Meiss, Schmidt, Dragstedt, Peterman and Seeger, Vaughn and Singer and our Case 2. Infrequently superficial ulcers are recorded, such as Hudson's (84) Case 1 and our Case 1.

TABLE II.—DEFINITE ULCER CASES—WITHOUT HISTOLOGICAL EXAMINATION

Author	Year	Age	Sex	Symptoms		Pre-operative diagnosis	Findings	Result	Remarks
				Inter- mittent pain	Acute ab- domen				
1. Deneke (2)	1903	7	M	+			Perforation at "throat, partially walled-off	Died	
2. Hildebrandt (21)	1903	8	M	+	+	Perforated appendix	Chronic penetrating ulcer adherent to parietal histological examination said without doubt that it was a peptic ulcer	Recovered	Not recognized as peptic ulcer by the author
3. Brestano (2)	1904	24	M	+	+	Appendicitis	Basal perforation with local abscess	Recovered	
4. Griffith (16)	1914	19 mo.	M	+	+	Asthenia	Perforation with local abscess Ulcer at tip	Died	
5. Jackson, R. H. (27)	1914	1	M		+	Surgical abdominal condition	Marginal ulcerated ulcer with eroded vessel	Recovered	Thought to have been a tuberculous ulcer
6. Seitz and Hordager (12)	1915	4	M	+	+	Ulcer Peritonitis	Perforated ulcer at base Peritonitis	Died	Consent only at operation
7. Seitz and Wenzinger (12)	1915	mo.	M	+	+	Asthenia	Perforated ulcer Walled-off retroperitoneal abscess	Died	
8. Alth and Strauss (1) (Case 2)	1916	mo.	M		+		Ulceration at tip of diverticulum	Recovered	
9. Mall (17)	1916	2 mo.		+	+	Intestinal polyp	Giant diverticulum with a chronic ulcer at base	Died	Overlooked at operation. Discovered at autopsy
10. Foss (14)	1916	37	F	+	+	Bleeding gastric ulcer	Sharply demarcated ulcer Mucosa ulcerated	Recovered	
11. Kleinbohl (28)	1917	45	M	+	+	Tumor	Perforated ulcer at tip—edematous	Recovered	
12. Shannon (18)	1918	8 mo.	F		+	Ulcer of Meckel's diverticulum	Ulcer at base perforating against bladder wall	Recovered	
13. Schwartz and Daly (41)	1919	8	M	+	+		Ulcer with eroded vessel	Recovered	
14. Smith and Hill (29)	1919	14 mo.	M	+	+	Intestinal obstruction	Partially walled off perforation at tip and intestinal obstruction	Recovered	Authors interpret their case as a peptic ulcer with diverticulus and obstruction

TABLE III.—PROBABLE PEPTIC ULCER CASES

Author	Year	Age	Sex	Symptoms			Pre-operative diagnosis	Gross findings	Histological findings	Result	Remarks
				Pain	Active at 12 M.	Active at 12 M. (Gastric)					
1. Biers (9)	1917	35	F	+	+	+	Peritonitis	Perforation lower lumen	Phlegmonous perforation. Large peptic ulcer.	Recovered	
2. Biers (9)	1917	5	M	+	+	+	Peritonitis	Perforation at lumen	Described as phlegmonous peritonitis. No mention of peptic ulcer.	Died	Perforation occurred 4 days after first bloody stool
3. McE and Strong (1) (Case 1)	1908	20	M		+	+		15 inch diverticulum filled with blood	Omental masses not described. The serosa state that gastric masses and ulcer may have been overlooked.	Recovered	
4. Biers (1)	1916	14 mo			+	+		Diverticulum adherent to intestine	Perforating mass. No ulcer described.	Recovered	Died later with severe diarrhea
5. Meyer and Johnson (11)	1908	8	M		+	+	Intestinal lymphoma of subserous coating	Inflamed diverticulum	One polyp and thickened submucosa. No mention of ulcer or gastric mass.	Recovered	
6. Tinkler (12)	1908	1 mo	M		+	+	Not opened. Died with respiratory collapse	Caustic diverticulum	Omental masses present. No ulcer.	Died	
7. Walsbrough (9)	1909	19 mo	M		+	+	Larva-infection	First operation: peritonitis, massive due to perforated diverticulum. Second operation: no perforated diverticulum, no perforated bleeding point. No ulcer.	Masses polypoid masses in peritoneum. Gastric masses found.	Recovered	
8. Henson and Knight (13) (Case 1)	1910	15 mo	M		+	+		Blood. Blood diverticulum	No histological data.	Recovered	
9. Henson and Knight (13) (Case 14)	1910	18	F	+	+	+		Blood. Blood diverticulum. Blood in intestine	No histological data.	Recovered	
10. Henson and Knight (13) (Case 15)	1910	13 mo	F	+	+	+		Meckel's diverticulum	Diverticulum was not removed.	Recovered	
11. Henson and Knight (13) (Case 16)	1910	11 mo	F	+	+	+		Meckel's diverticulum	No histological data.	Recovered	
12. Henson and Knight (13) (Case 17)	1910	1 1/2	F	+	+	+		Meckel's diverticulum—no ulcer	Acute inflammation and gastric ulcer.	Recovered	
13. Henson and Knight (13) (Case 18)	1911	11	M	+	+	+	Dissected ulcer (X-ray)	Adhesions about gall bladder. Perforated diverticulum. Ulcer of diverticulum adherent to colon.	Typical ulcer at tip. Ulcer masses.	Recovered	
14. Henson (14) (Case 4)	1911		F	+	+	+	Aggravation, post-operative. Recurrence of pain and motion.	Blood diverticulum. Chronic inflammation.	Omental masses present. No ulcer found.	Recovered	
15. Henson (14) (Case 5)	1911	1	F		+	+		Blood. Blood diverticulum. Ulcer in intestine.	Omental masses present. No ulcer or perforation.	Recovered	
16. Henson (14) (Case 6)	1911	3 mo	M		+	+		Interruption of intestine 30 inches long. Continued with ulcers not demonstrated.	Gastric masses present.	Recovered	

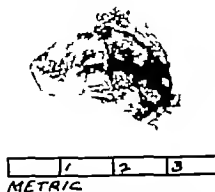


Fig. 1. Case 1. A photograph of the diverticulum which was excised with a narrow cuff of intestinal wall.

The process of hemorrhage, which is described in its clinical phase later in this paper, is probably more frequent in the chronic penetrating type of ulcer. In 5 instances grossly eroded vessels have been described. In 4 cases gross blood was observed in the intestine or large bowel at the time of operation and in the cases of Ulrich, Peterman and Seeger and Hudson (24) (Case 3) bleeding occurred into the peritoneal cavity at the time of perforation. Our Case 1 and Hudson's (24) Case 1 prove quite conclusively that massive hemorrhage may occur from very superficial ulcers or erosions of the mucous membrane. The fact that months or even years may elapse between hemorrhages indicates that an ulcer may be quiescent over a long period, and very likely there is in such cases temporary complete healing of the ulcer. Certainly in our Case 1, which had suffered a massive hemorrhage 6 months before the one which brought her to our attention, there was little evidence of a chronic type of ulcer. It is our belief as has been suggested by one or two writers, that in some of the cases listed in Table III, in which ulcers were not found at operation any one of three conditions must have existed: (1) the ulcer or erosion may have been so superficial that it was overlooked; (2) a superficial erosion may have healed previous to operation; (3) the ulcer may have been located in the ileum where it was not seen.

Perforation, which may be either an acute or chronic process, has occurred in more than one-half of the cases reported. The acute perforation appears as a punched-out lentil shaped opening in or near the crevice at the base of the diverticulum. Except for its shape it strikingly resembles the acute perforation of a gastric or duodenal ulcer. Many of the acute perforations have resulted in general peritonitis, but, as pointed out by Vaughn and Singer, the conditions are more favorable to immediate plugging or sealing than in

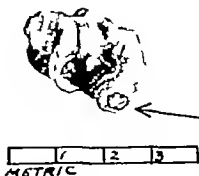


Fig. 2. Case 1. A slightly retouched photograph of the interior of the diverticulum shown in Figure 1. A shallow superficial ulcer is seen at the junction of the diverticular and intestinal mucous membranes. The ulcer extends into the intestinal mucosa. The mucosa of the diverticulum is intact.

similar perforations of gastric and duodenal ulcers. Because of the small size of the perforation and the mobility of the diverticulum, the hole may be plugged by mucus or fibrin, sealed by omentum or a loop of intestine, or by adhesions to the abdominal wall. In addition to our case we have listed in this group the cases of Gramen, Etcheberry, Peterman and Seeger, Achaner and Karelitz, Vaughn and Singer and Smith and Hill. Certainly a number of the other walled off perforations, if all the facts were known, probably could be added to this group. It is quite definite however that walled-off perforations are often the result of a chronic slow process. Some cases of walled off perforations have proceeded to the formation of peritoneal, mesenteric, or retroperitoneal abscesses. Intestinal obstruction has also followed local abscess formation.

The close analogy of the peptic ulcer of Meckel's diverticulum to the jejunal ulcer located at a gastro-enterostomy stoma has been suggested by several writers. Huebschmann was the first to make such a comparison. Guibal says that Meckel's diverticulum behaves like a miniature stomach. Stulz and Woringer state that the boring quality of the ulcer is demonstrated not only by the fact that it rapidly reaches the serosa and perforates but also by its tendency to hollow out a niche in the mesentery, or to penetrate the abdominal wall after adhesions are formed. They feel that in this respect the analogy with duodenal or gastrojejunal ulcer is perfect. Haberer has reported the coexistence of two duodenal ulcers and an ulcer of Meckel's diverticulum. Schreuder reports a case of Meckel's diverticulum ulcer in which the outer aspect of the pylorus led the operator to do a pyloric resection but no definite pyloric ulcer was found in the specimen. In their



Fig. 3. Case 1. A low power magnification of a section of the diverticulum shown in Figures 1 and 2. The arrow points to the ulcer area. The cuff of intestinal mucosa is to the right of the ulcer. The entire length of diverticular mucosa to the left is shown by high power magnification to be gastric in type.

discussion of the genesis of peptic ulcer Lindau and Wulff express their belief that the process in Meckel's diverticulum supports the biochemical theory of the origin of peptic ulcer. Matthews and Dragstedt have produced typical chronic

ulcers of the Meckel's diverticulum type by anastomosing small Pavlov pouches to the lower end of the ileum.

The condition is much more common in the male. Of the definite ulcer cases (Tables I and II) 40 were in males, 9 in females, and in 4 the sex was not stated. Although the age varied from 5 months to 45 years, the ulcers are predominately in infants and children. Nine or 14 per cent were less than 1 year, 12 or 19 per cent, were 1 and 2 years, 3 or 5 per cent, were 3 and 4 years, 14, or 23 per cent, were 5 to 10 years, 15, or 24 per cent, were 11 to 16 years, and 7 or 11 per cent, were 16 to 45 years. The age was not given in 2 cases.

Intestinal hemorrhage is the most constant symptom of this condition. While in some instances only a few tarry or slightly bloody stools are passed, the hemorrhage, however, is usually a massive one. The bloody stool may vary in color from bright red to black, although it is usually of a dark red color. Collapse may result from a single massive hemorrhage, or a succession of lesser hemorrhages may reduce the patient within a few days or weeks to a state of extreme anemia, in which condition perforation is very prone to occur. If the child does not develop a perforation he is likely to recover and then after the lapse of weeks, months, or even years, to suffer a recurrence of the hemorrhages. This tendency to recurrence is a striking characteristic of this condition. After a typical massive hemorrhage the hemoglobin may be reduced to 20 per cent or 30 per cent and the red blood cell count to 1,500,000. All of the cases listed in Tables I and II have given a history of intestinal hemorrhage, except 11 cases of acute perforation, in which the perforation was the initial symptom of the condition.

Next to hemorrhage the most frequent complication is perforation, the process of which we have



Fig. 4. Case 2. A semi diagrammatic drawing showing the pinched-out lenticular perforation at the base of the diverticulum.



Fig 5 Case 2. Low power magnification of a section cut through the diverticulum. This section shows a cuff of intestinal mucosa, the acute punched out perforation and the fibrotic thickened wall of the diverticulum. The mucous membrane of the diverticulum is of gastric type.

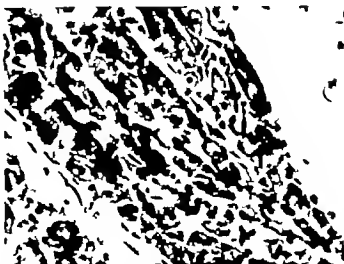


Fig 6 Case 2. High power magnification of the mucous membrane of the diverticulum illustrated in Figures 4 and 5, showing the fundus type of gastric glands with chief and parietal cells.

already described. In 5 cases perforation developed while the infant or child was under observation for intestinal hemorrhage. Of 67 cases with definite ulcer formation, 37, or 59 per cent, have perforated. Of the 37 cases of perforation 7 cases, or 19 per cent, were acute perforations which quickly became sealed or plugged, 18 cases, or 49 per cent, were acute perforations with peritonitis, and 12 cases, or 32 per cent, were walled off perforations, some of which resulted in local abscess formation.

Prior to perforation symptoms other than intestinal hemorrhage are generally lacking. In several cases in older children or adults there have been symptoms of abdominal distress. Unless the inflammatory changes about a chronic ulcer have reached the visceral peritoneum there is no pain, rigidity, or tenderness, but there may be a colic like distress at the onset of a massive hemorrhage. This colic is not as acute as in intussusception and it quickly subsides. In some instances large hemorrhages may be unassociated with appreciable distress. The walled off perforations are characterized by variable degrees of tenderness, rigidity, and distention. A local abscess when present has seldom been large enough to form a palpable mass. The diagnosis in this group has frequently been appendicitis, appendiceal abscess, or intussusception. The acute perforation followed by diffuse peritonitis presents the usual picture of a very acute surgical abdomen. Cases in this group and the walled-off perforative group if associated with or preceded by massive intestinal hemorrhages, may with considerable

certainly be given a diagnosis of perforation of peptic ulcer of Meckel's diverticulum.

In the differential diagnosis the blood dyscrasias are easily eliminated. Bleeding time and clotting time are normal. The blood picture is that of an acute secondary anemia. In the cases with perforation a leucocytosis is present. Duodenal or gastric ulcers are eliminated by the absence of digestive symptoms and by a negative roentgenological study. The Meckel's diverticulum can not ordinarily be demonstrated by the X ray, because the barium does not enter it. The only case on record which was demonstrated by the X ray is Case 23 in the series of Hudson and Koplik. The diagnosis of intussusception is eliminated by the lack of obstructive signs, the lack of intense colic, the absence of a palpable mass, and the absence of mucus in the bloody stool. Rectal polypi may be excluded by palpation or proctoscopic examination. The other common pathological conditions of Meckel's diverticulum—acute diverticulitis, gangrene, and intussusception, as well as intestinal conditions such as obstruction, intussusception, and polypi—may be associated with some evidences of intestinal bleeding but they usually do not produce the recurrent massive hemorrhages seen in ulcer of Meckel's diverticulum.

To date, in addition to our Case 1 ulcer of Meckel's diverticulum has been diagnosed previous to operation by Jackson, Peterman and Seeger, Shannon, Hudson and Koplik, and Greenwald and Steiner.

The treatment of peptic ulcer of Meckel's diver-

TABLE IV—MORTALITY

	Cases
1 Ulcers not perforated	
Operated upon	23
Recovered	20
Died (not discovered at operation)	
Not operated upon	3
Died (of other causes)	2
2 Perforated ulcers	7
Acute perforations quickly walled off (all operated upon, all recovered)	
Acute perforations with peritonitis	13
Operated upon	7
Recovered	7
Died (not discovered at operation)	20
Not operated upon, died	
Walled off perforations, with or without local abscess	
Operated upon	
Recovered	3
Died	
Not operated upon, both died	

culum is obviously surgical. In the cases with hemorrhage an exploratory operation is indicated after preliminary blood transfusions. While it is true that a number of very anemic patients have developed acute perforation while under observation, it is our opinion that the very weakened infant or child should be given the benefit of a few days rest and repeated blood transfusions so that he may be a better operative risk. In our Case 3 blood transfusions during the week before operation raised the hemoglobin from 35 to 80 per cent. It is extremely important, however, to insist upon operation at the earliest possible moment, and not to allow the patient's improved appearance to dissuade one from performing early exploration. In any case which has perforated, immediate operation is required, and also a blood transfusion when there is a definite anemia present. In most cases the diverticulum can be excised with a narrow cuff of intestinal wall in some a resection of a segment of the ileum is necessary. Table IV reveals an almost perfect surgical record in all types except the general peritonitis group in which the mortality was more than 50 per cent. The patients who were not treated surgically have nearly all died.

SUMMARY

Peptic ulcer of Meckel's diverticulum is a pathological condition which has its greatest incidence in male infants and children. The characteristic symptom is recurrent massive intestinal hemorrhage. More than one half of the cases have been complicated by perforation of the ulcer. In the group without perforation, the diagnosis is based upon the history of intestinal hemorrhage and except for anemia, the lack of physical findings. The group with perforation presents a picture of local or diffuse peritonitis, and usually but not invariably have a history of recurrent massive intestinal hemorrhages. The surgical record is ex-

ceedingly good in all cases except the group with general peritonitis.

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URINARY CALCULI ASSOCIATED WITH PARATHYROID DISEASE

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THE fundamental problem in the consideration of urinary tract calculi is the prevention of recurrence. When one considers the fact that the great clinics of the country report from 20 to 40 per cent recurrence in nephrolithiasis (13) the importance of this situation becomes evident. The fact that kidney stone, as well as bladder stone is a symptom rather than a disease is well recognized at the present time. The surgical removal of the calculus without any attempt to discover the reason for its growth must lead to recurrence in many instances. Thus we are led inevitably to a discussion of the causes of urinary lithiasis.

This question of stone formation is extremely complex and has absorbed the interest of the physiologist, the biochemist, and the clinician. From the mass of experimental and clinical data gathered together on the subject, certain facts stand out as important.

First, as regards the urine itself, we know that here is the extraordinary phenomenon of an extremely supersaturated solution which does not obey the ordinary laws of chemical solutions (11). Substances excreted by the kidneys are but slightly soluble in water as uric acid and calcium oxalate, uric acid being from ten to twenty times more soluble in urine than in water.

In a 24 hour amount of urine there is a greater quantity of salts than could possibly remain in solution in an equal volume of water. The ability of the urine to hold these salts in solution is said to be due to the presence in the urine of protective colloids. They prevent the precipitation of the salts and inhibit the formation of calculi. If the colloids are diminished in amount or if their action is interfered with as by chemical changes such as occur in stagnant urine the protective mechanism is lacking and the excess of free salts is precipitated with a resulting formation of urinary calculi. Again as has been shown experimentally, a marked increase in the crystalline content of the urine at times apparently so adds to the burden put on the colloids that they are unable to perform their protective action. This was successfully demonstrated by Keyser who fed oxamid to rabbits and dogs and produced oxamid concretions in the kidneys. Despite such experiments, stones have not been produced in animals by feeding them an excess of their normal dietary constituents (3).

Stone formation in the urinary tract, then, is the result of an abnormal precipitation of the crystalline elements normally present in the urine. The causes of this abnormal precipitation are probably multiple, for as Randall points out. We are practically forced to acknowledge that the chemical change that allows a pure uric acid stone to form must differ from that whence an oxalate stone is crystallized. As the chemical results vary so must the chemical cause.

There is considerable evidence that obstruction plays an important part in stone formation. Its rôle as regards bladder calculi can hardly be disputed and it is probable that the same is true for kidney stones. In his oxamid experiments Keyser found that when obstruction to the ureter was artificially produced stones formed consistently and within a few days. Most of the clinicians who write upon this subject regard urinary stasis as fertile soil for subsequent stone formation. It is also true that in many long standing cases of marked obstruction such as hydronephrosis from aberrant vessels, valves, or strictures, stones do not develop. But if in such instances a faulty metabolism acts markedly to the crystalline content of the urine it is reasonable to suppose that calculous will result.

The importance of infection as a cause of stone formation is difficult to evaluate. Many stones develop in an uninfected urine, and in many instances of severe and long standing sepsis of the urinary tract, stone formation never occurs. Urea splitting organisms inhabit the urine at times and phosphatic deposits frequently result, such as the incrustations in the bladder diseased by an alkaline cystitis.

Diets deficient in vitamin A, prolonged for some time, cause crystalline deposits in the urinary tract of laboratory animals (12). Ranganathan in India also found that stones produced on such diets to which calcium was added were composed chiefly of calcium, while stones produced when lime was not added were composed of magnesium ammonium phosphate. The excretion of large amounts of calcium in the urine seemed to affect the composition of the stones. Such dietary deficiency experiments go far to explain the geographical incidence of stone, such as its prevalence in certain parts of India and China, or the frequent occurrence of calculi among children so or



Fig. 1. Case 1. Intravenous pyelogram showing normal kidney pelvises with a large stone in the right kidney pelvis.



Fig. 2. Case 1. Roentgenogram of femur showing normal calcification.

more years ago. They apply far less, however, to our own present problems.

It has been proved that the parathyroid glands affect calcium metabolism. Total extirpation of these glands causes a fall in the serum calcium and results in tetany. Within recent years it has been

shown that tumors of the parathyroids cause marked metabolic changes with a loss of bone cal-



Fig. 3. Case 3. Stone low in right ureter. The bones show little if any change.



Fig. 4. Case 3. Radiographic catheter in place in same patient as in Figure 3. The stone has disappeared.



Fig 5 Case 3. Large stone in right kidney pelvis. The bones show some decalcification.

cium, elevation of the serum calcium, and increase in the urinary output of calcium. The resulting bony changes decalcification, cysts, benign giant cell tumors, and spontaneous fractures characterize the condition known as generalized osteitis fibrosa (2, 4, 5, 10). Crystalline deposits occur in the urinary tract with such frequency in this disease that the association of the two is more than coincidence. In 28 cases of generalized osteitis fibrosa collected by Rankin, renal calculi were present in 5, or 18 per cent, and in 4 cases of his own described in detail, from which tumors of the parathyroids were removed at operation, renal stones were present in all. In 2 of these cases the stones were bilateral.

The pouring out of calcium from the body through the urinary tract seems to result in stone formation in many patients with hyperparathyroidism (1). Very likely the marked increase in urinary crystalloids in this condition places such a burden on the protective colloid mechanism of the urine that stones are apt to form. How important a place urinary stasis assumes in this evident tendency to stone formation in parathyroid disease is not yet determined, but there is evidence that obstruction is a considerable factor. Mandl recently describes experiments in which 10 guinea pigs were given 10 units of parathyroid hormone daily for 4 weeks. Artificial urinary obstruction was produced by compression of the urethra for from 7 to



Fig 6 Case 3. Well marked decalcification of the long bones.

12 hours a day. Eight animals lived and 3, or 37 per cent, developed crystalline deposits in the renal pelvis. At autopsy the other organs were essentially negative and stones had formed in none of the controls.

Parathyroid tumors have been removed from 13 patients at the Massachusetts General Hospital. In 8, or 61 per cent, demonstrable calcification was present in the urinary tract. There were 6 instances of renal calculi, 1 bladder stone, and calcification in the kidney parenchyma in 2 (once in a case of nephroblastoma). Three of these patients had bilateral renal stones, a rather common condition in this disease. It is important that 3 of these individuals presented themselves to the hospital with the history of renal colic, hæmaturia, and other signs typical of kidney stone, and without the usual symptoms of generalized osteitis fibrosa. While one of the patients showed a certain amount of decalcification of the bones, in general such changes were not prominent and were quite overshadowed by the renal lesions. Probably an increased calcium intake maintained the calcium balance enough to prevent more



Fig 7. Case 3. Parathyroid tumor removed from Case 3. Actual size, 1.5 by 1 by 1 centimeter

extensive bone changes. The true condition was recognized in these 3 patients by discovering a high serum calcium and low serum phosphorus. These tests have been performed routinely in all cases of nephrolithiasis for some time at this hospital. As the association between urinary tract stone and parathyroid disease is more generally appreciated many more instances of a similar nature are certain to be recognized.

A report of 3 cases of nephrolithiasis associated with parathyroid disease serves to illustrate certain of these facts.

The first case is that of a 32 year old Italian-American shoemaker who entered the hospital in October, 1933 complaining of hematuria and intermittent pain in the right kidney region. Previously well, he first noticed bloody urine a year ago after extreme exertion or when fatigued. Seven months ago he was seized with an attack of severe right flank pain radiating to the testicle. He was taken to a hospital had a cystoscopic examination, and 10 days later passed a stone. Since then he has had three attacks of pain and has passed three stones. Two weeks ago a similar pain on the left side radiated to the testicle. Physical examination showed a healthy young male with no abnormalities save tenderness about the right kidney. The urine contained a little albumin and many red blood corpuscles. Cystoscopy and pyelograms demonstrated normally functioning, uninfected kidneys with a moderate sized dense calculus in the right renal pelvis. The bones gave no evidence of decalcification. The blood calcium was 15.78 milligrams per 100 cubic centimeters and the phosphorus, 3.8 milligrams. On October 4, 1933 the renal calculus was removed through a pyelotomy incision. No obstructive lesions were detected and the patient did well. About 3 weeks later a tumor of the parathyroid was removed by Dr. E. D. Churchill. The tumor measured 1.7 centimeters in diameter and on pathological examination was found to be an adenoma of the parathyroid.

This patient is interesting because the only symptoms present were referable to the urinary tract, yet this was a case of hyperparathyroidism. Had the true condition not been recognized by the routine estimation of serum calcium and phosphorus, and had a tumor of the parathyroids not been removed, undoubtedly a rapid recurrence of the urinary stones would have followed. The entire absence of bone decalcification is also a noteworthy feature and may be explained by the fact that the patient's diet was very rich in milk.



Fig 8. Photomicrograph of parathyroid tumor removed in Case 3.

Of more interest in certain respects is the case of a fifty-one year old married woman who entered the private ward of the hospital in June 1933.

Eleven years ago the left kidney was removed for extensive calculus disease. Since then she has occasionally passed gravel. Three years ago a stone was removed from the right kidney and in May 1933 X ray examination showed a recurrent stone in this solitary right kidney. The blood calcium was 12.5 the phosphorus 3.19 and the patient was considered a case of hyperparathyroidism. A palpable tumor in the neck strengthened this point of view. During the next month the stone became impacted in the upper ureter, the patient was extremely ill and returned to the hospital. No urine was excreted for 48 hours, the non-protein nitrogen was elevated and the temperature was high. A hurried operation was performed to relieve the anuria. Upon exposure of the kidney dense scar tissue was encountered everywhere. The kidney itself was dark and swollen, its parenchyma studded with milky abscesses. The stone could not be found nor was any extended search made for it. The obstructed kidney was relieved by a large nephrostomy tube. The patient gradually recovered after a stormy convalescence, nitrogen retention became normal and kidney function improved. The nephrostomy was considered probably as permanent in view of the extensive renal damage and existing stone. However the stone gradually worked its way toward the bladder and, by the middle of August could be felt by vagina. X ray examination of the bones showed no marked evidence of decalcification.

On October 7, 1933 Dr. Churchill explored the neck for a parathyroid tumor. The swelling previously noted proved to be an adenoma of the thyroid, but after a long, painstaking search a parathyroid adenoma was found in the region of the suprasternal notch and removed. Ten days later cystoscopy and X ray examination failed to show the presence of the stone. The patient was in splendid condition and soon afterward the nephrostomy tube was removed to allow the wound to heal.

This second case is another example of an individual with hyperparathyroidism with outstanding symptoms of nephrolithiasis. The recurrence of stones, so common in this disease, nearly resulted in death. Here again noticeable bone decalcification was not a feature and this may have been due to the fact that this patient had been on a gastric ulcer regimen for some time, thus keeping the calcium intake unusually high. A rather remarkable fact is the disappearance of the stone so soon after the removal of the parathyroid tumor. It is possible of course that the stone reached the bladder and was voided, although the patient was in the hospital at the time and its passage should have been noticed. Possibly the stone softened and was resolved into crystals. Whether or not the removal of the parathyroid tumor affected this cannot be said at the present. In other individuals with urinary tract stones, no difference in the size of the stones has been detected after the removal of a parathyroid tumor.

The third case is that of a 55 year old married woman who entered the hospital September 1932, complaining of right flank pain of 5 years duration. In 1927 the gall bladder had been removed, a point relieving the symptoms. During the past year severe pain came on more frequent attacks, and she became easily fatigued. Several times suffered joints were said to have been due to rheumatism of many years standing. She often passed large quantities of urine. On physical examination tenderness as present in the region of the right kidney. The blood pressure was 130/90. The urine contained both pus and blood. X-ray examination showed a large dumb bell shaped calculus in the right kidney pelvis. In all of the bones abnormal trabeculation and decalcification were well marked. The right thumb and femur were distinctly smaller than the bones of the opposite side. The serum calcium was 11.1 mg. per 100 ml., the phosphorus was 55.1 mg. per 100 ml. The renal stone was easily removed by operation, and months later small adenoma of the parathyroid measuring 3 by 3 by 3 millimeter was excised.

The last patient's chief symptoms were also those of nephrolithiasis, but in this instance noticeable bone changes together with the high serum calcium and low phosphorus added to the suspicion of parathyroid disease and aided in making the correct diagnosis. It is worthy of note

that this individual very rarely drank any milk and that bone decalcification was marked.

CONCLUSIONS

Tumors of the parathyroid cause metabolic disturbances which result in a marked increase in the urinary output of calcium, a decrease in the output of phosphorus, and lead to the formation of stones in the urinary tract in many instances. While generalized osteitis fibrosa is frequently accompanied by urolithiasis, it is important to recognize the fact that stone formation occurs often in the urinary tract without any of the bone changes which characterize this disease, although tumors of the parathyroids are present and are the underlying cause of the stone formation. Unless the parathyroid tumor is removed stones will frequently recur.

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EXTRAPLEURAL PNEUMOLYSIS WITH PARAFFIN PACK

IN THE TREATMENT OF PULMONARY TUBERCULOSIS

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THIS paper is a report of 28 cases of pulmonary tuberculosis treated by extrapleural pneumolysis with paraffin pack. One can offer two excuses for the presentation of so small a series: (1) the operation has such narrow indications that for most the accumulation of a larger group would require many years and (2) whereas in Europe the procedure has been used since 1912 and is gaining rapidly in popularity, in this country most have rejected it without trial on the basis that it is unsurgical.

HISTORY

In 1891 Tuffier (38) in resecting the apex of a lung which was the seat of tuberculosis finding that the pleurae were adherent, discovered that the lung could be easily mobilized by stripping the parietal pleura from the chest wall. He realized then that this offered a means of producing pulmonary compression but it was not until 1910 that he so used it. In 1907, Schlange confronted with a patient bleeding dangerously from an apical cavity, separated the adherent apex from the ribs and packed the extrapleural space with iodoform gauze. The hemorrhage was controlled. In 1911, Tuffier (36) reported 6 cases of non tuberculous pulmonary suppuration which he had treated in this manner using homogenous and exogenous fat grafts to maintain the compression. In the next year he used the operation for the first time on a case of pulmonary tuberculosis. The operation attracted little attention until 1913 when Gustave Baer (4) ignorant of the work of Tuffier reported a series of cases in which he had performed an extrapleural pneumolysis and filled the cavity with paraffin. Within the next year Sauerbruch (28) Wilms and other German and Austrian surgeons adopted the operation and in 1914 Sauerbruch reported 28 cases. By 1920 he (29) had added only 12 more.

The operation was slow to gain adherents. Brauer and many others objected *a priori* to the foreign body and the early results were not encouraging. The indications and technique were poorly understood, complications were frequent and the cures few. Sauerbruch more than any one else, is responsible for its development and popularization. Confident that it had its uses and could be perfected, he persisted. At the present

time he has performed the procedure more than 1000 times and is employing it more and more frequently. His experience and that of others has so clarified and developed the indications and so reduced the incidence of complications that within the past decade the operation has grown rapidly in favor. Brauer so long opposed has adopted it and Baer (5), Schreiber and Stocklin, Ranzi, Tuffier (37), Hauke, Sachs and Sperl, Roth, Waltuch, Denk and Domanig, Kremer and Beitz, Alexander, Winternitz, Walzel, Behrens and others in Italy and the Scandinavian countries have reported more or less extensive groups of cases. In this country most of the leaders of opinion in thoracic surgery have frowned upon, without trying it and the literature to date consists of an imported article by Nissen, a report of observations in European clinics by Rogers, and a preliminary report of cases operated upon by Randolph. John Alexander has used it for several years and a record of his experiences is soon to appear.

THE INDICATIONS

The conditions for which the operation is now generally used are as follows:

1. Productive unilateral and bilateral apical lesions with single or multiple small cavities which do not extend below the fourth or fifth ribs at the spine and in which there is no active or progressing disease and no disease in remainder of lung.

2. Large cavities and more extensive lesions in cases in which the age or condition of the patient or disease in the opposite lung contra indicate thoracoplasty.

3. Cavities which have remained open after complete thoracoplasty.

4. Hemorrhage from apical cavities which can not otherwise be controlled.

The first indication is the only one that has been disputed. Many have held that, when thoracoplasty was feasible, the operation should never be used. Sauerbruch (31) was long of this opinion but has lately adopted it as the operation of choice for small apical cavities. As the complications have been reduced its advantages have demanded greater consideration. It is simpler, safer and less deforming than thoracoplasty and is the only method of collapsing diseased without sacrificing normal lung.

It is my belief that the indications will be determined less by the complications than by the results. If statistics eventually show that it is relatively certain of closing cavities which would otherwise necessitate resection of more than 4 ribs, it will be the preferable procedure. I have found that when a cavity extends lower than the fourth rib at the spine thoracoplasty is more certain to produce a satisfactory collapse. In doubtful cases, however, I am often influenced in favor of pneumolysis by the considerations that it may suffice and that if it does not, a subsequent thoracoplasty will be more certainly effective. For very large cavities, those closed with difficulty by any procedure I am now employing it as a preliminary to thoracoplasty.

THE TECHNIQUE

The operation, save in exceptional cases, is used to collapse the apex of the lung. The approach may be either from in front through the first interspace or second rib bed or from behind after resection of a segment of the third rib. Baer (6) believes that the choice of route should be determined by the location of the lesion. The anterior operation is the easier to perform since the chest wall can be reached by splitting the pectoralis major and the extrapleural space by separating the intercostal muscles. These considerations have led Schreiber and Stocklin, Sachs and Spert, Starcke, Behrens, Maendli and Schwarzman, and many others to prefer it. The posterior operation, while it necessitates section of the muscles of the shoulder girdle and removal of a segment of rib affords better access to the apex and far greater possibilities of securing a satisfactory collapse. Most surgeons who have had experience with both now use only this approach. Among these are Sauerbruch (29) Hauke, Wintermitz, Kremer and Beitz, and J. Alexander. I have used the posterior operation 19 times, the anterior 8. All of the satisfactory results have followed the former.

The extrapleural plane having been located, the parietal pleura is stripped from the chest wall with the finger. The use of instruments favors injury to the lung. The stripping must be done with great gentleness and caution. If the pleura are not adherent the parietal layer may be torn. In some cases the inflammation has extended through both layers and rendered the outer one adherent to the endothoracic fascia, ribs, and intercostal muscles. Such adhesions tear less easily than the lung so that there is definite danger of pushing one's finger into the cavity he wishes to collapse. If dissection of the plane with the finger

is not easily accomplished it should be abandoned. In many cases it is impossible to secure a satisfactory collapse. The extent to which the stripping is carried determines the size of the pack and some experience and judgment are required to make this fit the disease at hand. Hauke has emphasized the advisability of freeing the entire apex so that the upper half of the cavity may be inverted into the lower half.

The packing material. Many substances have been used to fill the extrapleural space and maintain the collapse. Tuffier (37) used fat, omentum, uterine fibromyomata, muscle and Beck's paste. Tuffier, Riviere and Romanis, and Mayer have attempted to maintain an extrapleural pneumothorax. Archibald has inserted pedicled muscle grafts. Gewerd, Schoenbank, and Kroh have experimented with rubber balloons. Wilms used the segments of ribs removed at thoracoplasty. Brauer and Helme report favorable results from the use of vivacol and Eden has employed human oil, an oil prepared from human fat. Jensen has used a mixture of cere alba—vaseline and bismuth.

Many of these have proved entirely unsatisfactory and none of them has demonstrated its superiority to the paraffin mixture of Baer. This is the material now generally used. The formula is as follows:

Paraffin, melting point 48-50	100.0 gm.
Vaseline	2 gm.
Bismuth carb. neut.	1.0 gm.

The size of the pack. The incidence of complications has borne a definite relation to the size of the pack. Sauerbruch (29) at first attempted several complete pneumolyses and inserted as much as 1,000 grams of paraffin. Schreiber and Stocklin and Hauke have used as much as 1,000 grams. The consensus of opinion today is that 600 grams should be the limit. Wintermitz has had excellent results and has not used more than 350 grams. None of my packs has exceeded 600 grams.

The insertion of the pack. Prior to the operation the paraffin is melted and then cooled gradually so that when needed it is of the consistency of putty and can readily be molded. I first wash the cavity out with salt solution and then with a solution of iodoforn in ether. The former to remove the blood and to make certain that the lung has not been perforated, the latter to dry and disinfect the surfaces. Small pieces of paraffin are inserted through the opening and molded into the recesses of the cavity until it is full. Packing in under pressure is apt to tear the lung, embarrass

the heart or great vessels, or compress the bronchus to the lower lobe.

Closure Firm closure of the incision in the rib bed is essential. Small openings through which paraffin or serum may escape favor the extrusion of the pack.

THE COMPLICATIONS

The nature of the complications and their incidence are shown in the following chart.

	Cases	Per cent
Number of cases	528	
Lung torn at operation	10	1.8
Pleura torn at operation	11	2
Infection of pack	12	2.2
Extrusion of pack	7	1.5
Perforation of pack into cavity	18	3.3
Pack slipped	6	1.1
Pneumonia or atelectasis	13	2.3
Operative death	21	3.8

The causes of the operative deaths are shown in the following chart.

	Cases
Pneumonia	10
Infection	2
Circulatory failure	4
Meningitis	2
Unrecorded	3
Total	21

Fear of complications arising from the foreign body has led many to reject the operation. Although these accidents were at first common, they are now rare. It is significant that when they do occur they are not serious and rarely prejudice the patient's chances for recovery. Although in the first 40 operations reported by Sauerbruch (29) in 1920, 16 packs had to be removed because of infection, extrusion or perforation, in the remaining 488 operations the incidence of these complications has been but 5.5 per cent. In his last 50 operations Hauke has had no trouble from the foreign body and in my series there have been none save in those 3 cases in which at the time of operation it was known that the lung had been torn.

The complications may be classified as operative, postoperative, and late.

I Operative complications

- a. Perforation of the pleura
- b. Perforation of the lung

II Postoperative complications

- a. Infection
- b. Emphysema
- c. Serous effusion
- d. Pressure on heart or great vessels
- e. Aspiration pneumonia or massive atelectasis
- f. Tuberculinization



Fig. 1. Case 1. Large cavity at the apex of the right lung. Phrenicotomy failed to influence it.

III Late complications

- a. Extrusion of the pack
- b. Perforation of the pack into the cavity
- c. Sliding of the pack

I a. Perforation of the pleura. The fact that the operation is indicated only when pneumothorax has been proved impossible makes this complication unlikely. If it does occur and the lung drops freely away the wound should be closed without insertion of the pack and pneumothorax continued artificially. If the tear is into a localized pocket and the lung elsewhere adherent the accident may be disregarded.

I b. Perforation of the lung. Refusal to use force or instruments in an attempt to separate adhesions should eliminate this complication. Heretofore, when the accident occurred the pack has been omitted and the wound tamponaded with gauze. This ensures a stormy and painful convalescence. In my cases I disregarded the tear and completed the operation. In each instance the immediate postoperative course was uneventful. In the two in which the pack was inserted from in front, serum appeared in the wound in the course of the second month. This finally evacuated itself and small pieces of paraffin were discharged. The patients had no fever. In each the pack was removed and at the same time the

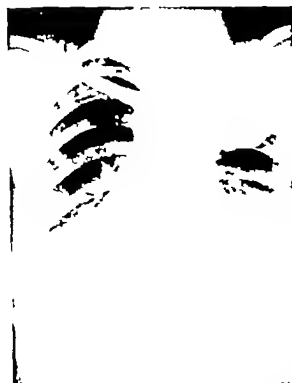


Fig. 2. Case 1. The cavity has been closed by a paraffin pack. The sputum has been negative for 3 years.

anterior stage of a thoracoplasty was performed. The results were satisfactory. In the case in which the pack was inserted from behind the wound remained sound, but several months later the patient began to expectorate small pieces of paraffin. Because the disease was incompletely collapsed the pack was finally removed and a thoracoplasty performed. At the operation filling the bed of the pack with fluid showed that the fistula was closed. The patient is now well.

II a. Infection in the wound. This is not and should not be more common than in clean wounds in which there is no foreign body. Occurrence of the complication calls for removal of the pack and disinfection of the wound. Nasen states that aspiration of the pus may lead to subsidence of the infection and retention of the paraffin.

II b. Emphysema. Baer (5) is the only one who has noted this complication. It occurs immediately after the operation in cases in which the lung has been injured. In one of mine an extensive subcutaneous emphysema subsided spontaneously. If pressure symptoms develop the wound must be opened and the pack removed.

II c. Serous effusion. It is probable that in every case a small amount of serum forms early

about the pack. In some it is sufficient to appear on the roentgenogram as a halo about the denser paraffin. Winternitz observed this in 4 of 105 cases. In my series it occurred once. Kremer and Belts believe that it is often the cause of a persistent fever. It should be aspirated only if it is copious, is causing symptoms, or seems to threaten the extrusion of the pack.

II d. Pressure on the heart or great vessels. This complication is rare and has been mentioned only by Sauerbruch (39). It occurs when large packs are put in under pressure. One of my patients had a transient dysphagia apparently from pressure on the esophagus, and another transient signs of irritation of the sympathetic nerves on the operated side.

II e. Aspiration pneumonia or massive atelectasis. These are the most common and dangerous complications and practically the only ones that may cause the death of the patient or prejudice his chances for ultimate recovery. Pneumonia and atelectasis are most likely to occur in patients with abundant sputum and soft disease. H. Alexander and Winternitz have both suggested that lower lobe atelectasis may be caused by pressure on the bronchus. To prevent the complications the patient should be made to rid himself of the sputum before the operation. After the operation the foot of the bed should be elevated, opiates withheld and cough encouraged.

II f. Tuberculinization. Sauerbruch (39) and Winternitz report instances of immediate severe intoxication. This they attribute to the flooding of the circulation with tuberculo-toxins incident to the sudden compression of the diseased lung. The symptoms are vomiting and prostration. The fever is high, the pulse small and rapid and the blood pressure low.

III a. Extrusion of the pack. The pack may be extruded weeks or months after the operation. Without the development of fever or other symptoms a fluctuant swelling appears in the wound. This may disappear spontaneously or after aspiration. In some cases it breaks through the skin with the evacuation of serous fluid and later of pieces of paraffin. A low grade infection ensues which necessitates removal of the pack. Riviere and Romanis, and Wilms each cite an instance of healing of the sinus and retention of the paraffin. Chaumiere and Loubat operated upon one case before the fluid perforated, removed a piece of paraffin which had worked out through the rib bed, and secured primary healing. Two of my packs were extruded, but in both instances it was known at the time of operation that the lung had been torn. Both followed the anterior operation.

TABLE I—RESULTS

Operator	Cases	Positive result	Improved	Unimproved	Worse	Operator death	Late death	Not followed	Observed too short period
Barr (5)	9	3	4						
Sauerbruch (29)	40	7	5	27		1			
Roth	1	4	6						
Sachs and Sperl	8	3	3						
Schreiber and Stocklin	3		6	3		3			
Alexander H.	20	6							
Winternitz	79	20		15		3	11		
Hanke	11	0	0	8	1		4		
Kremer and Beitz	2	0	0	1			2		
Raazi	0	0	6						
Waltuch	15	7		4		2			
Desk and Dornanig	50	0	2	4		4	2		6
Head	28	10	15		1	0	0	0	
Totals	317	8	15	25	5	16	20		7
Per cent		35	24	17	6	5	6	3	2

*Total number of cases in which these data were recorded

It is my belief that injury to the lung and unsatisfactory closure of the incision are the causative factors.

After removal of the pack the wound is tamponaded and allowed to granulate. In my cases I performed at the same time the anterior stage of a thoracoplasty. Nissen and Kremer and Beitz report cases in which the temporary compression had permitted healing of the tuberculosis.

III b Perforation into the cavity. This is a more common complication and may occur weeks, months, or years after the operation. Sauerbruch cites instances of its appearance after intervals of 4, 5, 6, 7, and 11 years. It may be caused by injury to the lung at the time of operation, by pressure necrosis of the cavity wall or by extension of the tuberculosis. It is not associated with stormy symptoms. The patient simply starts expectorating small bronchial plugs of paraffin. This may stop, as in my case and in ones reported by J. Alexander and Kremer and Beitz. If fever develops or the expectoration of paraffin persists the pack must be removed. It has been customary to tamponade the wound and allow it to heal by granulation. I would risk a primary closure and if necessary, at the same time would do a thoracoplasty. In many cases the pack perforates long after the tuberculosis has healed. This was so in most of the 9 observed by Winternitz.



Fig. 3. Case 2. Very large cavity at the apex of the left lung. hemolateral phrenicectomy contralateral pneumothorax.

RESULTS

It is not reasonable to judge any operation by the results obtained during the period of its evolution or by the early results of any given operator. Only by group and individual experience can the indications be determined and the dangers recognized and avoided. What is a perilous course to the explorer becomes, once the shoals and reefs are charted, a safe channel for travel and commerce.

The results at present available show this operation during the period of its development. In many instances too much was attempted, too vigorous efforts were made to separate adhesions, too large packs were used, they were put in under pressure and too often the anterior operation was employed with the result that the collapse was limited and the closure of the wound unsatisfactory.

Even the statistics at hand are not so classified and analyzed that they are of more than general value. Like artificial pneumothorax, extrapleural pneumolysis is a trial operation. In many cases adhesions prevent a satisfactory collapse. Like artificial pneumothorax and phrenicectomy it is applicable and used in a great variety of situations for a great variety of purposes. One can ask only that it accomplish the purpose for which



Fig. 4. Case 2. A paraffin pack has been inserted in an attempt to close the cavity. The sputum continued to show bacilli.

it was employed. It is not reasonable to expect that it will cure the patient or render the sputum negative when there is active disease in the opposite lung. Proper statistics, therefore, must include information on all of these points and the cases must be classified and reclassified according to the particular indications and the nature and distribution of the disease.

An approximation of the general results obtained by the different operators is shown in Table I.

Table I shows 33 per cent cured, 34 per cent unimproved, 12.6 per cent unimproved, 2.4 per cent worse, 5 per cent early deaths, 6.3 per cent late deaths, 33 per cent not followed and 2.2 per cent followed too short a time. These results compare favorably with those of thoracoplasty. When one considers this and the fact that in a majority of these cases disease in the opposite lung or some other complication contra indicated the larger operation, he must agree with Winternitz that the operation cannot be lightly discarded.

The results in a group of 89 unilateral cases presented in Table II shows 49 per cent cured, 35 per cent improved, 4.5 per cent unimproved 2.3 per cent worse, 4.5 per cent dead, and 3.5 per cent of the patients observed for too short a period of time.



Fig. 5. Case 2. The paraffin has been removed and a thoracoplasty performed. The sputum has been negative for 11 months.

Kremer and Bents were able to secure a satisfactory collapse in 38 of 48 cases. Twenty-two patients had been observed more than 1 year. Three of these who had had bilateral packs all still had bacilli in the sputum. In 5 other cases there was a cavity in the opposite lung. Three of these had a satisfactory contralateral pneumothorax and negative sputum. Of 6 cases with unilateral disease and satisfactory inversion packs, 4 had negative, 2 positive sputum. In 3 other cases the cavity was pressed against the mediastinum. All had negative sputum. Four cases had relaxation packs. Two of these died of tuberculosis and the other two still had bacilli in the sputum. In a total of 52 operations the results were satisfactory in 66.6 per cent. Of 12 cases observed one year following successful packs, 9 had negative sputum.

During the past 2 years I have performed a total of 30 operations upon 28 patients. Two had bilateral packs. The general results are shown in Table III.

In 18 instances the posterior operation was used, in 8 the anterior. In one the pack was

TABLE II—RESULTS IN UNILATERAL CASES

Operator	Cases	Cured	Improved	Unimproved	Worse	Dead	Too short period
Head	14	9	3		0	0	
Kremer and Betz	13	7	4	0		2	
Roth	10	4	3	0	0	0	3
Sachs and Spert	3	3		0			
Hauke	9	0	6	3		1	
Rasm	8	3	3				3
Schreiber and Stocklin	3	0	3	0	0		
Wallack	12	5	4				
Beer (2)	3	3		0	0	0	
Total	89	43	31	4	3	4	6
Percent		48	35	4.5	3	4.5	7.0

TABLE III

Operative deaths	Cases
Lat. death	
Infection of pack	0
Pleura torn	0
Lung torn	3
Pack extruded	3
Pack perforated	1
Subcutaneous emphysema	1
Effusion about pack	1
Massive atelectasis of lower lobe	
Exsufflation of lower lobe disease	
Spill into the opposite lung	0
Cured	0
Improved	0
Unimproved	5
Worse	3
Dead	

1 both the lung was torn 1 operation
1 lung torn 1 operation

inserted at the base and in two in which it was used to complete a thoracoplasty through the axilla. No conclusions can be drawn from the statistics on this subject. Although all of the good results followed the posterior operation the anterior was used in no ideal cases and in only two with unilateral disease.

In 6 cases the indications were ideal the disease being limited to one apex and not extending below the fourth rib at the spine. In 10 the disease was unilateral but the cavities either large or the involvement extensive. In 9 there was active disease in the opposite lung and in 3 the operation was done to complete a thoracoplasty. The results in these different groups are shown in Table IV.

In 12 cases the operation accomplished the purpose for which it was used in 9 it rendered the sputum negative in 2 it improved the condition so that thoracoplasty could be performed and in 1 it stopped repeated hemorrhages. In 10 be

TABLE IV

	Cases	Sputum negative	Improved	Unimproved	Worse	Dead	Operation accomplished purpose	Have had thoracoplasty	To have thoracoplasty	Sputum negative
Ideal cases	6	5	0	0		0	6		0	6
Large cavities	10	3	5	2	0	0	5	3	3	4
Bilateral cases	9		7			0	1	5		3
After thoracoplasty	3	0	3	0	0	0		0	0	0
Total	38	8	15	2		0	13	7	3	13

cause of disease in the opposite lung it is impossible to tell whether or not it has closed the lesion attacked. In 7 it failed to accomplish its purpose in 2 because the pack was extruded and in 5 because it failed to close large apical cavities.

In none of the cases in which it failed has it prevented a subsequent thoracoplasty. It is my present belief that one of its chief uses will be as a preliminary operation. Not only will it improve the condition of patients too ill for thoracoplasty, but in the presence of large cavities, those closed with difficulty by any method it will so decrease their size that a subsequent thoracoplasty will be more certainly effective.

SUMMARY AND CONCLUSIONS

Extrapleural pneumolysis with paraffin pack has a definite place in the surgical treatment of pulmonary tuberculosis. The complications caused by the foreign body which have deterred many from using it have been largely eliminated. When they do occur, they are rarely serious and rarely prejudice the patient's chances for recovery. It has the great advantages of being simpler, safer, and less deforming than thoracoplasty and of making a strictly localized collapse of diseased lung without sacrificing vital capacity. For these reasons it can be used in a large group of cases in which all other methods are either impossible, contra-indicated or have failed. It has thus increased appreciably the number of patients amenable to collapse therapy. Whether or not it should ever be used in preference to thoracoplasty is still a subject of dispute. Sauerbruch and Brauer, the leaders of opinion in Germany have recently changed their ideas and now believe it the operation of choice for small apical cavities. It has been my experience that in cases in which the cavity does not extend lower than the fourth rib at the spine, it is reasonably certain of producing

the desired result. For larger cavities thoracoplasty is more certain. When the indications are doubtful, one may be influenced by the consideration that the lesser operation may suffice and that if it does not a later thoracoplasty will be more certainly effective for the partial collapse already provided. My results from such secondary thoracoplasties have been so good that at present, when confronted with a very large apical cavity I am using a pack as a preliminary operation.

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THE INTRA-UTERINE DIAGNOSIS OF MONSTROSITIES

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EVERY obstetrician is all too cognizant of the shock and disappointment to the family for whom he has just delivered a monster. How much greater is the shock and disappointment when it occurs without a diagnosis previous to birth! In addition, is the fact that the known presence of a monstrosity may change the entire treatment. He who prides himself on the recovery of a woman upon whom he has done a caesarean section only to deliver a monster, certainly has no obstetrical conscience.

There are only two means of absolute diagnosis of intra uterine monstrosities available. First of these is by employment of roentgenology and the second by direct palpation of the abnormal condition vaginally. Only within the last 10 years has roentgenology been so perfected as to help us with this diagnosis. As it is needless expense to the patient to use the X ray in every case of pregnancy, it is imperative to select those cases for study that show clinical signs or associations pointing to the presence of a monstrosity.

The frequent association of marked polyhydramnios with monstrosity has been known for years. Eleven years ago Greenhill called attention to the association of fetal monstrosities and placenta previa. Undoubtedly many spontaneous abortions are associated with the presence of monstrosities as well as many cases of unexplained fetal death *in utero*. In 1928 Falls reviewed the literature on tentative and actual diagnosis of intra uterine monsters and reported 10 cases in 5 the diagnosis was definitely made before birth.

During the past 3 years the author has encountered 5 cases of monstrosities in all of whom fortunately a diagnosis was made before delivery. In 4 of the cases the diagnosis was made by the X ray but in each case there was a definite indication for roentgenology either to confirm the tentative diagnosis or to assist in the diagnosis of intra-uterine death. The fifth case was one of teratocormus cyllosooma similar to that recently reported by Boulware and Flinn. Convulsive movements of the fetus and irregular fetal heart tones were not observed in any of the cases. Of the 5 mothers 3 had previously borne healthy babes and in no case was syphilis a likely factor

of age. Her past history was negative and she had had none of the infectious diseases of childhood. Her menses had started at 13 years, were regular and of 28 day type. The first day of her last period was April 5 1931 making her due January 12 1932. Blood pressure was 120-70 measurements were normal. Wassermann reaction was negative. Urinalysis was negative. Prenatal period was negative as to symptomatology. Notes as to abdominal palpation and weight were as follows.

Date	Position	F.H.T	H.F	WT
8-19-1931	O.L.T	160	80	88½
9-2-1931	O.L.T	160	74	93½
10-30-1931	?	160	3	98½
11-17-1931	Breech	144	26½	17½
12-1-1931	?	?	31	115½

On the last date there was an acute polyhydramnios with marked tension of abdominal wall, preventing palpation. Patient was roentgenographed because of this fact.

X ray report. Anteroposterior and lateral films of the abdomen and pelvis showed the bony outline of a rather small fetus. There was a very marked disturbance of the development of the bones of the fetal skull. We saw only the smaller bones of the face and base of the skull. The vault of the skull was entirely undeveloped. We noted also a marked splitting of the upper dorsal vertebrae. The appearance was that of a fetal monstrosity probably of the type of craniorachischisis (Fig 1).

Patient entered hospital December 1 1931. The membranes were ruptured artificially at 10 a.m. December 3 1931. 5500 cubic centimeters amniotic fluid were slowly removed. Pains began at 1:30 p.m. and the patient delivered a female anencephalic stillborn monster at 7:00 p.m. The puerperium was uneventful.

Case 2. E. W. aged 28 years, a primipara was first seen by me July 30, 1931. Her husband, both her parents, and 6 sisters were living and well. She had had measles, mumps, scarlet fever and a tonsillectomy. Menses started at 14, were regular and of the 27 day type. The first day of the last period was April 12 1931 making her due January 18, 1932. On December 22, 1931 she had delivered an 8 pound 9 ounce girl spontaneously. General examination was negative. Local examination showed an acutely inflamed cervix and vagina, and the presence of Trichomonas vaginalis. The uterus was the size of a 3 months pregnancy. Measurements were normal. Wassermann, Kahn, and Kline tests were negative. Her prenatal period was normal until at the visit on November 17 1931 she reported slight headache with slight bleeding 2 days previously. Blood pressure was 120-70 weight 107.50. Height of fundus was 27 centimeters. The babe was active and fetal heart tones were 140. On November 30, 1931 the patient reported no fetal movements felt for 48 hours. There were no signs of toxemia. No fetal heart tones could be heard by careful auscultation with the head stethoscope. Height of the fundus had dropped to 24.5 centimeters. Because of suspected fetal death hospitalization was advised and patient entered the Methodist Hospital December 4, 1931. As no fetal heart tones could be heard after another careful examination, the patient was roentgenographed and a fetus with a maldeveloped head and apparently deformed thoracic cage was shown. After bag induction a macerated female monstrosity of

Case 1. G. P. Hospital No C3407, primipara I. The patient's first visit to the prenatal clinic at the Coleman Hospital was July 28, 1931. She was then 27 years



Fig. 2 Case 2 Anencephalic monster

a praenotrhachytic type was delivered. The placenta was strongly attached to the uterine wall and required manual removal. Patient made an uneventful recovery, highest temperature 99 degrees, left hospital tenth day.

CASE 3. L. V. aged 30 years, 4-para, was first seen by me July 15, 1932. Her husband, both parents, and sister were living and well. She had had measles, mumps, whooping cough, and appendectomy. Meneses started at 4, were of the 28 day type and the first day of the last period was April 8, 1931, making her due February 4, 1932. She had delivered a 7 pound, 6 ounce, girl by breech extraction at Danville, Illinois on November 10, 1928. General examination was negative. Measurements were normal. Prenatal period was uneventful, except that babe persisted in breech position, and all attempts at external version failed. Patient entered the Methodist Hospital on January 30, 1933, shortly after rupture of the membranes. There was no presenting part palpated by rectal examination, and because the part in the fundus, though feeling like a head, seemed to be much too large for one, the patient was roentgenographed. The roentgenologist made a definite diagnosis of hydrocephalic monster with breech presentation (Fig. 2). The situation was explained to the husband, as well as the operative treatment probably required. The patient was given castor oil, 1 ounce and quinine sulphate, 5 grains. Pains started at 1:15 a.m. The breech was on the perineum at 5:00 a.m. the same day. Babe was extracted up to the head which was so large it would not enter the pelvis. After considerable difficulty a craniotomy was done in the suboccipital region and extraction completed. Babe was a boy with large hydrocephalic head but on spine bifida. Mother made an uneventful recovery, highest temperature 99.4 degrees.

CASE 4. H. B. aged 7 years, primipara, was first seen at the Crittenden Home December 2, 1932. She had had none of the infectious diseases of childhood. Her menses started at 3 years, and the first day of the last period was



Fig. 3 Case 3 Hydrocephalic monster

May 9, 1923, making her due February 16, 1933. Blood pressure was 90-80. General examination was essentially negative as were Wassermann, Kahn, and Kline tests. All findings were normal except my inability to make a clear cut abdominal diagnosis. Notations taken from her chart pertaining to abdominal examination follow:

Date	Position	FHT	H F
1-1-1933	P	20	30
2-15-1933	OLT (?)	20	30
3-1-1933	P	20	30
4-1-1933	OLT (?)	20	30
5-1-1933	OLT (?)	20	30
6-1-1933	OLT (?)	20	30
7-1-1933	OLT (?)	20	30
8-1-1933	OLT (?)	20	30

On the last date recorded above, rectal examination showed the pelvis to be empty. Abdominal examination did not demonstrate the presence of a head in the fundus. Monstrosity was suspected and patient was sent to the Methodist Hospital for X-ray examination. The latter showed definitely the presence of an anencephalic monster and was reported as such. Four days later the patient went into labor and delivered spontaneously an anencephalic monster with suboccipital meningocele the size of a coconut. The babe lived but a short time. Fetal heart tones had been within normal limits throughout labor and continued at a normal rate as long as the babe lived.

CASE 5. B. N. aged 35 years, 4-m-para, was admitted to the Coleman Hospital July 3, 1933. She was sent to us as an emergency case with a diagnosis of placenta previa by her family doctor. She was having irregular pains and

some vaginal bleeding. Her membranes had ruptured at noon, July 1, 1933. She felt the babe move at midnight the same day but had not felt movements since that time. She was about term, but no fetal heart tones could be heard. The abdomen was so tense that babe could not be outlined. I saw the patient after the resident reported that by internal examination, he felt something inside the cervix but was not sure what it was. Upon vaginal examination, we felt smooth tissue inside the cervix, which did not feel like placental tissue. The cervix was dilated about 5 centimeters. Putting slight traction on the tissue, bleeding was not increased and the tissue readily came down into the vaginal canal. A small amount of the tissue was delivered out of the vulva. On inspection it appeared like fetal bowel. A small loop was excised after ligation and both ends carbolized. The patient was allowed to labor her general condition being satisfactory. Tissue was examined at the laboratory and a definite diagnosis of hemorrhagic bowel made. We were then certain that we had a monstrosity with prolapse of the fetal bowel and a partial abruptio placentae was suspected. An X ray film added nothing to our information, except that breech presentation, sacrum dextra anterior and marked angulation of the spine and mild overlapping of some of the bones of the skull were shown. Patient delivered spontaneously 10:40 p.m. July 4, 1933 the placenta being delivered simultaneously with the macerated babe (Fig 3). The mother made an uneventful recovery.

Pathological report. The body for dissection is that of a white male (?) slightly premature macerated fetus. The head and all its parts, the thorax, and upper extremities appear normal. The abdominal contents are completely eviscerated. The placenta is still attached to this mass of abdominal contents. There is no anus and only a rudimentary penis. On the left thigh is a small wart like formation about the size of a pea. There are bilateral club feet. The skin over the entire fetus is scaly. Upon closer examination of the eviscerated portion, the loops of intestine are very imperfectly formed and have undergone considerable deterioration. In and about this portion are small rudimentary organs which grossly can be identified as liver, spleen, pancreas and one kidney. No bladder or genital organs can be demonstrated. The rudimentary penis has a urethra but no meatus. Upon opening the thorax, the lungs appeared normal. The right had three lobes and the left two lobes. Both lungs are atelectatic. The thymus is about normal size. The heart is well formed. The ductus arteriosus and foramen ovale are patent.

Anatomical diagnosis. Congenital malformation of abdominal viscera.

SUMMARY

Five cases of monstrosities *in utero* diagnosed before delivery are reported. The first 4 cases were diagnosed by means of the X ray and the last by direct palpation. The first case was examined by X ray because of the presence of acute polyhydramnios. The second case was discovered because we were attempting to find X ray evidence of fetal death. The third case was submitted to the X ray because of the abnormally large fetal head, while the fourth was found because of careful frequent abdominal examinations revealing the absence of a demonstrable head either in the pelvis or in the fundus. The fifth case, diagnosed by direct palpation presented a



Fig 3. Case 5. Teratocormus cylindroma

very unusual condition. The importance of the subject is sufficient to require re-emphasis and the following conclusions

CONCLUSIONS

1. The intra uterine diagnosis of fetal monstrosity is to be highly desired.
2. Cases of suspected intra uterine death should be roentgenographed. In addition to the cardinal findings of fetal death—overlapping of bones of the skull, acute angulation of the spine and compression of the thoracic cage—often the presence of a monstrosity will be shown.
3. During the latter months of pregnancy, repeated abdominal examinations are urged. Failure to outline a normal fetal head abdominally or in the pelvis is a definite indication for X ray examination as is every case of marked polyhydramnios.
4. When possible, every candidate for cesarean section should be roentgenographed and especially so in cases of placenta previa.

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TREATMENT OF SUPPURATIVE OSTEOMYELITIS OF THE MANDIBLE

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THE method of treatment of suppurative osteomyelitis¹ of the mandible described in this paper was given trial because of the unsatisfactory results which had been obtained by the use of the more conservative plans.

A review of the records of 85 cases of suppurative osteomyelitis of the jaw treated according to the conservative methods in the Peiping Union Medical College between the years 1922 and 1932 showed certain points of interest. In 90 per cent of the cases, the disease was of more than 3 months' duration when the patients were first seen. These cases were treated over periods varying from 2 months to 2 years (an average of 6.4 months) after which apparent healing occurred in only 39.1 per cent of the cases. In the remaining 61.9 per cent of the cases there was evidence of active infection of bone when the patients were last seen. These results proved disappointing, particularly in a group of cases in which so much time had been allowed for the separation of sequestra and the regeneration of bone.

The conservative method of treatment consisted, during the acute stage, in drainage of the

The three suppurative osteomyelitis as used here applies only to those cases which are characterized by acute or late extensive necrosis of the body of the ramus of the mandible. This condition should be differentiated from the localized infection of bone (osteitis) associated with an acute dento-alveolar abscess. In dento-alveolar abscess the destruction of bone is confined to the periapical region, and the establishment of early drainage and extraction of the involved teeth usually serve to arrest the process. Occasionally as a result of local extension of an abscess of this type, small sequestra formed in the periapical bone are formed, but such lesions should not be mistaken under the term "suppurative osteomyelitis" unless secondary spread occurs in the body of the jaw bone can be demonstrated.

abscess, and, during the chronic stage, in removal of the dead bone which had been allowed to separate spontaneously. Usually the infected teeth were not extracted until very late in the chronic stage. Radical operation was not attempted previous to the formation of new bone sufficient to maintain continuity. This necessitated a delay of at least 3 to 6 months, or until roentgenograms showed that sequestra had separated definitely before the dead bone could be removed. The sequestra were removed through incisions either within the mouth or externally along the border of the mandible. Usually sinuses had formed both on the inside and on the outside of the mouth.

Most writers (especially Blair, Axhausen, Dunning, Wilensky) advise conservative treatment much the same as that described in the preceding paragraph. Several writers (Enderlin, Germain, Hardgrove) have advised opening of the bone during the early acute stage of the disease, but this procedure has been the subject of severe criticism, chiefly because of the danger of extension of the infection following operative trauma during the acute stage. Before the present plan had been developed, experience in one of our cases served to emphasize the necessity for caution when dealing with acute infections in this bone.

HIST. A Chinese male, 27 years of age, was first seen on October 31, 1932. The patient stated that 7 days previously he had suffered from a toothache in the right lower



Fig. 1. Schematic drawing of the mandible to illustrate points of interest in the surgical anatomy. Except for a small portion in the region of the mental foramen, the outer plate has been removed to expose the medullary bone which extends from the mandibular canal forward to the gonion. The inferior dental artery and its branches are shown.



Fig. 2. Schematic drawing of the operative field after removal of the outer plate from the molar and incisor regions (see text).

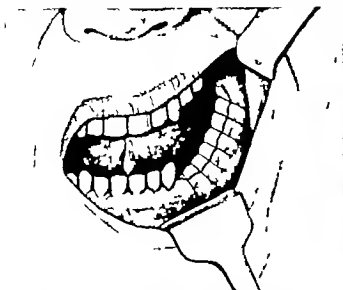


Fig. 3. Schematic illustration showing the gums sutured together. This procedure (second stage of operation) is carried out after the tooth sockets have been extirpated.

molar region, and within a few hours a painful swelling had developed in the right submaxillary and parotid regions. Entrance examination showed essentially normal findings except for the surgical condition. The right side of the face was swollen greatly and there was definite hypoesthesia of the right lower lip in the distribution of the mental nerve. There was no definite fluctuation of the external swelling. Intra-oral examination was difficult because of marked trismus. There was definite redness and tenderness around the region of the right lower third molar tooth. Pus flowed from the gum margins of the molar and premolar teeth. The soft palate and the anterior pillar of the tonsil on the right side were inflamed. On the following day the patient was admitted to the hospital. The patient's temperature was 39 degrees C. Examination of the blood showed 4,470,000 red cells, 66 per cent hemoglobin (Sahli) and 18,150 white blood cells with 87 per cent polymorphonuclear leukocytes. The urine contained a trace of albumin, a few white blood cells, and a few granular casts. The Wassermann and Kahn blood tests were definitely positive. Cul-

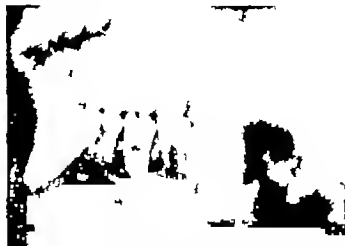


Fig. 4. Pre-operative roentgenogram showing osteomyelitis of the outer plate of the ramus and of the body of the mandible as far forward as the canine tooth (Case 3 of Statistical Table).

tures of pus taken from the intra-oral sinuses showed hemolytic streptococcus. Blood cultures showed no growth. Examination of the stool showed ova of ascariis. The diagnosis, acute osteomyelitis of the right mandible secondary to alveolar abscess of the right lower third molar tooth, was confirmed by roentgenograms.

On November 2, 1935, a radical operation was performed under nerve block anesthesia. An incision was made from the lower margin of the parotid gland down to the angle of the jaw and was extended forward along the inferior margin of the mandible for about 1.5 inches. Subperiosteal dissection allowed exposure of the facial plate of the bone in this region. By means of a hand drill, a small hole was made into the bone at the region of the apex of the impacted third molar tooth. Foul smelling yellow pus escaped from the drill hole. By means of a rongeur this hole was enlarged so that it was approximately 1.5 centimeters long and 1 centimeter wide. The mandibular canal in this region was found to be filled with pus. The wound was left wide open and was packed loosely with vaseline gauze over which dry dressings were applied. Next, the mouth was held open by means of a retractor and the right lower molar and pre-



Fig. 5 A

Fig. 5. A Pre-operative roentgenogram of mandible (Case 6 of Statistical Table) showing osteomyelitis in the molar and premolar regions. Note the pathologic fracture



Fig. 5 B

in the premolar area. B Roentgenogram of the mandible (3 months after operation) of the same case. Note that the osteomyelitis and the fracture are healed.



Fig 6 A

Fig 6 A. Pre-operative roentgenogram of mandible (Case 1 of Statistical Table) showing extensive osteomyelitis of the outer plate of the ramus and body of the



Fig 6 B

mandible. B. Roentgenogram of mandible (3 months after operation) of the same case as shown in Figure 6A, showing healed osteomyelitis.

molar teeth were extracted. The alveolar process was removed so as to allow a direct communication between the tooth sockets and the external wound. Then the gum margins were sutured together.

The patient failed to show improvement following the operation. Two days later he became delirious. There was marked exophthalmos of the right side of the face and neck and slight exophthalmos of the right eye with definite lagging of its motions. Repeated blood transfusions failed to bring about improvement. (Cultures of blood taken following the operation showed non-hemolytic streptococcus.) The white blood cell count increased gradually. The local swell-

ing increased and there were definite signs of cavernous sinus thrombosis. The patient died on November 11.

TREATMENT IN THE RECENT SERIES

All recent cases of acute and chronic osteomyelitis of the mandible were given special study which led to the formulation of the following plan of management. The method in its entirety has been used only on patients over 14 years of age.

Treatment during the acute stage. Except for the treatment of the teeth, the method of management adopted for the acute stage of the infection was essentially the same as that used in the former series. It consisted of early drainage of the abscess at the point of greatest swelling or fluctuation. The location and path of dissection made by the abscess determined whether the incisions were made on the inside of the mouth or on the outside. In one case the pus broke through the bone and formed a sinus on the lingual plate of the mandible. This was uncommon because in most other cases the pus broke through the lateral plate and formed subperiosteal abscesses which pointed in the gums just lateral to the affected teeth or externally along the lower border of the body of the mandible. In cases in which chiefly the ramus was involved, the abscesses were deeply seated beneath the masseter muscle and produced marked swelling of the parotid region. To drain abscesses of the latter type incisions were usually made along the posterior border of the ramus. Care was taken not to injure the parotid gland and facial nerve. Following incision of the abscess, vaseline gauze drains were used and hot compresses were applied.



Fig 7. Photograph (Case 1 of Statistical Table) to illustrate the type of scar which follows the operative treatment presented in this paper.

The treatment of the affected teeth varied in different cases. In most instances there was extreme loosening of the molar and bicuspid teeth over the area of osteomyelitis. The loosening was due to an associated suppurative periodontitis and to an early necrosis and softening of the alveolar process. At this time (between 14 and 21 days after the onset), the teeth which were greatly loosened and bathed in pus were extracted. Other less affected teeth were allowed to remain in position.

In most instances the acute reaction subsided after 10 days or 2 weeks of conservative treatment. The gradual increase of the patient's resistance and the decrease of the virulence of the infection were evidenced by a steady lowering of the temperature together with signs of lessening of the local inflammation. When drainage was maintained adequately during the subacute stage (10 to 21 days), the patients showed progressive improvement. After 21 days the period of infection was designated 'early chronic stage'. Stereoscopic roentgenograms taken at the second or third week usually showed signs such as motting, decreased density, and haziness in the bone.

Treatment during the chronic stage. The plan of operative treatment during the early and late chronic stages differed from former methods by including the following steps—especially steps 3, 4 and 5.

1. An adequate external incision was made along the lower border of the mandible. To expose the posterior portion of the body, the insertion of the masseter muscle was severed and the muscle was retracted laterally (Fig. 2). When exposure of the ramus was necessary, the incision was extended upward along the posterior border. By careful dissection the sheath of the parotid gland was separated from the fascia of the masseter muscle and the inferior portion of the gland was retracted posteriorly. Care was taken to avoid injury to the branches of the facial nerve.

2. Subperiosteal dissection was made carefully to allow exposure of *only the involved area* of the facial plate without needless stripping of the periosteum. Usually it was noted at the time of operation that the abscess had caused an elevation of the periosteum over the most involved area of the facial plate. When the abscess cavity was opened, necrotic cortical bone was seen.

3. As soon as possible after the acute stage (after 21 days from the time of onset), the necrotic portion of the facial plate was removed regardless of whether or not it had separated definitely in the form of a sequestrum. Care was taken not to injure the mandibular nerve and artery. Pieces of

uninvolved bone overhanging the necrotic area also were removed carefully, avoiding unnecessary trauma to the soft tissue and bone. Usually the involved bone was removed by means of a rongeur. The use of the mallet and chisel was avoided whenever possible.

4. The external wound was left wide open and was packed loosely with vaseline gauze over which dry dressings were applied. Experience in the treatment of osteomyelitis has shown that partial closure of the wound usually prevents free drainage and thereby favors prolongation and direct extension of the disease.

5. With the mouth held open by means of a retractor the remaining teeth which were loose and bathed in pus were extracted. The alveolar process on the facial wall was removed by means of a rongeur. This produced a free and direct communication between the infected tooth sockets and the external wound. Occasionally also, the uppermost portions of the alveolar process were removed from the lingual plate. Thus, after the tooth sockets were exteriorized the gum margins were sewed together directly over them so as to prevent further drainage of pus into the mouth and seepage of mouth secretion down to the bone. Sinuses existing in the sockets of teeth previously extracted or in their immediate neighborhood were closed in the same way. During the operative procedure, a suction tube was placed behind the tongue to prevent aspiration of the purulent material.

6. The usual methods of immobilization of the mandible were used. In some cases half round German silver bars were bent to fit the labial arch of the teeth. Before operation, these bars were wired to the upper and lower arches, and after operation the jaws were approximated and the bars were connected together by means of brass wires. In other cases wire loops were applied to the teeth as in the standard method used for fracture of the mandible. In 1 case silver cap splints were cemented on the upper and lower teeth of the unaffected side, and these were locked together after operation.

Postoperative treatment. Whenever possible, immobilization was continued for periods varying from 2 weeks to 2 or even 3 months, the duration of these periods depended upon the rapidity of healing and the presence or absence of pathological fracture. Oral cleanliness was maintained as well as possible by the use of frequent irrigations of the mouth cavity, washing of the mouth by the patient was contra indicated because the bellows motion of the cheek would have disturbed the line of sutures in the gums. Liquids and

pureed food were fed to the patient through a small tube or a catheter. The dressing in the external wound was allowed to remain intact for a period varying from 2 or 3 days to a week or more. As in the Orr treatment of osteomyelitis of other bones of the body, the frequency of change of dressings was determined by the amount of discharge from the wound. During the first 2 or 3 dressings, only the external gauze was changed—the vaseline gauze was left undisturbed within the external wound. After a week or two the vaseline pack was removed and a new one was inserted also, the stitches in the gums were removed.

In order to emphasize the points of interest in the surgical management of these cases, the following records have been selected for detailed report.

Complete removal of necrotic bone 30 days after onset Osteomyelitis cured 3 months after operation.

CASE 1: A Chinese male, aged 33 years, was first seen on April 4, 1933. The entrance complaint was pain in the right lower jaw. Three weeks previously the patient had suffered from a toothache which was followed 5 days later by swelling and drainage of pus into the mouth.

The general physical examination showed essentially normal findings. Local examination showed swelling and fluctuation near the angle of the lower jaw on the right side. The gums around the loosened buccal and molar teeth were swollen. There was considerable purulent discharge from the gums adjacent to the right lower first molar. There was distinct hypoesthesia of the area supplied by the mental nerve on the right side. Because of marked trismus the patient was able to separate the incisor teeth only one-fourth of the normal distance. The patient's temperature was 99 degrees C. Examination of the blood showed a white blood cell count of 1,000. Roentgenograms showed suggestive evidence of early acute osteomyelitis of the lower portion of the ramus and of the body of the mandible beneath the right molar teeth. On April 7, 1933, an external incision was made over the lower border of the mandible. The subperiosteal abscess was opened and about 55 cubic centimeters of foul smelling green pus was evacuated. Then, the mouth was opened and the right lower buccal and molar teeth, which were loosened, were extracted. Iodoform gauze drains were placed in the sockets of the teeth. Conservative treatment, consisting of hot dressings and oral hygiene, was used. On April 15 the lower jaw was prepared for immobilization by the application of wire loops to the teeth.

On April 18, 1933 (23 days after onset of osteomyelitis) a major operation was performed under ether anesthesia. A curved incision was made from a point just below the lobe of the ear to the angle of the jaw and was continued forward along the lower border of the mandible to within centimeters of the symphysis menti. The incision was carried through the platysma muscle, exposing the body of the bone. The facial plate of the bone from the angle of the jaw to the external oblique ridge was necrotic, consequently it was removed. The outer plate of the ramus was of normal color and consistency, and bled freely; therefore, it was left intact. The lingual plate of the bone was intact. Strips of vaseline gauze were packed loosely into the wound. The mouth was opened and sponges were placed in the posterior part of the oral cavity to prevent the pus from flowing into

the pharynx. The tissues overlying the alveolus were retracted laterally and medially and the bone was examined carefully. The alveolar process was firm but its edges were rough. The lateral alveolar margin was trimmed, by means of a rongeur, until a free communication existed between the tooth sockets and the external wound. The gum tissues were approximated with interrupted chromic catgut sutures, thus closing off the mouth cavity from the infected area. The patient reacted normally during the operation and was returned to the ward in good condition. The jaws were wired together after the patient had recovered from the effects of the anesthetic.

There was no drainage of pus made of the mouth after the radical operation. The external wound was dressed at weekly intervals with vaseline gauze over which dry dressings were applied. Two months after the operation it had healed completely. The resultant function and occlusion was excellent. There was no pain and no discomfort except that which was the result of persistent numbness in the distribution of the mental nerve. Clinical and roentgenological findings indicated that the osteomyelitis was healed. Further examinations confirmed the latter findings. The last examination was made 6 months after operation, and at that time the numbness in the skin supplied by the mental nerve had disappeared.

In this case drainage of pus into the mouth was prevented by the procedure described in the new plan of management. It was believed that early drainage and extraction of the teeth prevented further involvement by direct extension.

Complete removal of necrotic bone 33 days after onset Immobilization of jaw for 3 months. Pathological fracture healed 3 months after operation. Osteomyelitis healed 4 months after operation.

CASE 2: A Chinese male, aged 27 years, was first seen on October 1, 1933. The patient stated that 3 days previously he had suffered from a toothache with swelling of the right side of the face. The general physical examination showed essentially normal findings except for the surgical condition. There was a large swelling in the region of the right lower jaw. Intra-oral examination revealed small draining sinus just lateral to the right lower second molar tooth. Thick yellow pus flowed from this sinus when pressure was applied to the external surface of the jaw. Roentgenograms showed an impacted right lower third molar tooth with irregular areas of destruction of bone around its roots. Trismus was marked. Hot dressings were applied over the jaw and 3 days later there was considerable increase of drainage from the gums around the second molar tooth. The patient had a temperature of 38.2 degrees C. Examination of the blood showed a white cell count of 3,400. On October 3, 1933, an external incision was made just below the angle of the mandible. About 30 cubic centimeters of thick, yellowish green pus was evacuated. Vaseline gauze drains were inserted. Following this operation, the patient showed a slight rise of temperature. Three days later the right lower second buccal and third molar teeth were extracted. These teeth were loose and were bathed in pus. A large amount of pus flowed from the sockets of these teeth. Following the extraction of the teeth, the patient's temperature subsided promptly to a level very near normal. Further exploration of the external wound was made on October 6, and several small sequestra were removed.

On October 21 (33 days after the acute onset) the incision was extended from the angle of the jaw to the symphysis menti and was continued upward along the posterior border of the ramus. After the bone had been exposed by

subperiosteal dissection, a pathological fracture was found just anterior to the angle of the jaw. Most of the outer plate of the body of the mandible and of the lower portion of the ramus was removed. The lingual plate of the mandible was intact and viable except at the point of pathological fracture in the region of the third molar whence, with a curette, a few necrotic apicules of bone were removed. The external wound was left wide open and was packed loosely with vaseline gauze over which dry dressings were applied. The remainder of the operation was performed inside of the mouth. The outer plate of the alveolus in the molar and premolar region was spongy and rough ended consequently it was removed. Also bits of softened bone were removed from the alveolar processes on the lingual side. After a direct communication had been established between the infected tooth sockets and the external wound, the gums were sutured together so that all intra-oral drainage was stopped. The jaw was immobilized by means of interdental wires fastened to the unaffected teeth and by an external bandage.

The patient had an uneventful postoperative convalescence. There was no further drainage inside the mouth. The interdental immobilization was continued for 3 months at the end of that time roentgenograms revealed that the pathological fracture had healed satisfactorily. Within 4 months after operation there was complete healing of the external wound. As in the other cases, the external wound was dressed at weekly intervals by means of vaseline gauze over which dry dressings were applied. The early result was very satisfactory. There was good occlusion and good function of the lower jaw.

Final follow-up examination, 13½ months after operation, showed an excellent result. Roentgenograms taken at that time showed good consolidation and reformation of the bone with no evidence of recurrence of infection.

The necrosis involved chiefly the outer plate of the bone from the angle of the jaw to the second bicuspid tooth. Since the lingual plate also was involved (there was a definite pathological fracture without solid involucrum), it was necessary to immobilize the mandible for a period of three months. After that time the pathological fracture had healed solidly with no disturbance of occlusion of the teeth. Within 4 months after operation the external wound had healed completely.

Removal of necrotic bone 3 months after onset. Healing of bone delayed because of attempt to save infected tooth. Osteomyelitis cured 3 months after operation.

CASE 3. A Chinese female, aged 34 years, was first seen on September 30, 1932. The patient stated that 27 days previously she had suffered from a toothache in the left lower molar region. On the seventh day after the onset of the toothache, a painful swelling had developed in the left submaxillary region and left cheek. Entrance examination revealed that all of the left molar and premolar teeth were loose. There was a purulent discharge in the left buccal fold. There was definite numbness in the left mental region. Further examination revealed definite evidence of a subperiosteal abscess on the facial plate of the left side of the mandible. Apparently the abscess was draining quite freely around the affected teeth. Hot magnesium sulphate compresses were prescribed and also Dobell's gargle and mouth wash. A short time later an external incision was made over the abscess. The patient failed to follow advice and did not return until December 9, 1932. At that time roentgenograms showed extensive osteomyelitis of the

central portion of the body of the mandible with a pathological fracture in the bicuspid region.

The patient was admitted for treatment on December 14, 1932. The temperature was normal, but the white blood cell count was 11,500. General physical examination revealed essentially normal findings. On December 14, 1932 (approximately 3 months after the acute onset) a major operation was performed under nerve block anesthesia. An external incision was made along the lower border of the mandible. The body of the bone was exposed by subperiosteal dissection. By means of a rongeur the facial plate of the mandible was easily removed from the region extending from the angle of the jaw to the mental foramen. Strips of vaseline gauze were placed in the cavity and dry dressings were placed over them.

Then with the mouth held open, the 2 left lower bicuspids and 2 molar teeth and the roots of the third molar were lifted out of their sockets. After the gums had been stripped free the alveolar process was found to be entirely separated in the form of a sequestrum 5 centimeters long and 1 centimeter wide. There was free dependent drainage of the remaining parts of the tooth sockets; hence the gum margins were approximated over them with interrupted silk sutures, thus stopping all drainage into the mouth cavity. There was a definite false point of motion in the involucrum in the premolar region.

Following the operation the jaw was immobilized by means of interdental wires and splints. The patient was very unco-operative and insisted on the removal of the wires 2 weeks later. According to clinical signs, the pathological fracture was healed approximately 1 month after operation. The external drainage was satisfactory, and the patient was comfortable. Following the closure of the oral sinuses, a very small amount of drainage persisted around the gum margins of the left canine tooth. When the patient was re-admitted 3 months later this tooth was extracted; its alveolar process was removed by means of a rongeur and its gum margins were sutured together by means of fine silk threads. In addition, the small external wound was enlarged and the remaining infection in the bone around the apex of the socket was extirpated and allowed to drain through the outside wound. The external wound healed completely four weeks after the second operation. The final result was excellent. The function of the jaw was very satisfactory. Occlusion was good. The final follow-up examination was made 6 months after the patient was operated upon.

In this case the osteomyelitis involved chiefly the facial plate with only a minor amount of necrosis of the lingual plate. The major operation was performed approximately 3 months after the acute onset. In spite of infection of the bone at its root and alveolus the left canine tooth was left intact at the first operation. It was hoped that new bone would form around its roots so that eventually it might be saved. The persistence of the drainage from around the alveolar process necessitated its extraction so as to clear up the remaining focus of infection. In a final analysis of this case, it was believed that all infection of the bone and soft tissue would have been healed in from 6 to 8 weeks provided that, at the major operation, the left lower canine tooth had been extracted and the partially necrotic bone removed from around its apex. Because this was

not done, final healing of the osteomyelitis was delayed until 3 months after the major operation.

Complete removal of necrotic bone 19 weeks after onset of osteomyelitis. Osteomyelitis healed 9 weeks after operation. Pathological fractures healed 13 weeks after operation.

CASE 4. A Chinese boy, aged 15 years, was first seen on February 9, 1933. The patient stated that 4½ months previously he had suffered from a toothache in the right lower molar region. Several days later a swelling had involved the entire right side of the face and purulent material had drained inside of the mouth. Three months prior to admission, the swelling had ruptured externally at two places near the angle of the jaw. At the time of admission there was drainage of pus from sinuses on the inside and on the outside of the mouth.

The boy was somewhat underdeveloped but quite well nourished and not acutely ill. He showed a slight fever (37.6 degrees C). Microscopic examination of the blood showed a white cell count of 13,000. The gums in the right lower molar region were reddened and swollen, and there was considerable purulent discharge from the region of the right lower second molar tooth. The whole right side of the face was swollen and indurated. There were two sinuses discharging externally in the submandibular region. The sinus tracts led to the bone. Roentgenograms showed definite evidence of extensive osteomyelitis of the body and ramus of the right half of the mandible. Interdental splints were made and wired to the uninvolved teeth of both jaws. (These splints were not fixed together however until after operation.)

On February 17, 1933, the patient was operated upon under ether anesthesia. An incision was made along the inferior border of the mandible from the symphysis mentis backward to the angle and then upward along the posterior border of the masseter muscle. Necrosis was seen in the ramus and body of the mandible from the mandibular to the mental foramina. In the region where the facial artery crossed the body of the mandible there was a plate of involucrum about 2 centimeters wide and 3 millimeters thick. All necrotic bone was removed. There was a well formed, but not absolutely solid, involucrum along the entire inner periosteal surface of the large sequestrum. There were two false points of motion (pathological fractures) in this involucrum, one at the angle of the jaw and another about 3 centimeters lateral to the symphysis mentis. It was believed that the involucrum would unite eventually to afford stability for that side of the lower jaw. The wound was left wide open and the cavity was packed loosely with strips of vaseline gauze, over which dry dressings were applied.

With the mouth held open by means of a retractor the right lower molar and premolar teeth were extracted and their alveolar processes were trimmed. There was a free communication between the deeper portions of the sockets of these teeth and the external world, hence the gum margins were sutured together over them, by means of catgut sutures.

The patient had an uneventful postoperative convalescence. His temperature and white blood cell count returned to normal quite promptly. Five days after operation, the external dressings and vaseline pack were removed, and new vaseline dressings were applied and bandaged into place. Because of the presence of two points of non-union, the jaw was immobilized for 3 months after operation. During that time dressings were reapplied approximately at weekly intervals. There was no drainage inside the mouth at any time after operation. The external wound filled with granulations rapidly and was healed completely 3½ months after operation. Three months after

operation roentgenograms showed a fair amount of new bone in the region of non-union, consequently the wires and splints were removed from the teeth, and exercises for mobilization of the mandible were started. On removal of the wires the occlusion was very satisfactory and within a few days the function of the lower jaw was excellent. The patient was last seen on October 6, 1933 (8 months after admission). He was advised to return at a later date for a plastic operation upon the cheek (removal of the scar at the lower border of the mandible).

In this case the operation was performed 4½ months after the onset of the disease. In spite of the pathological fracture—the involucrum was not yet solid—all necrotic bone was removed. By means of interdental wires the mandible was immobilized for 3 months. At the end of that time the two areas of non-union had become solid. There was no purulent drainage into the mouth after the operation.

EVALUATION

In the cases presented, the osteomyelitis was of odontogenous origin and the commonest source of infection was from impacted third molar teeth. It should be emphasized again that the method of treatment described in this paper was used only on patients over 14 years of age.¹

The question of retaining or removing loose teeth was one that caused much controversy and the treatment was varied in different cases. In all of our cases the outer plate of the body of the mandible and of the alveolus was involved in a necrotizing process and the periodontal membranes of the molar and bicuspid teeth showed suppurative inflammation. *The teeth involved most severely were always found to be very loose and bled in pus and they were removed only when these conditions were present.* In 3 cases extractions were performed within 21 days after the onset of the disease with the hope of relieving the tension of the inflammatory products in the body of the bone itself. Removal of the teeth was followed by welling up of pus from the sockets. It was interesting to note that in Case 3 following external incision and drainage of the abscess, the temperature remained elevated, but that it subsided promptly after the removal of the molar and bicuspid teeth. (Sections taken from pulp tissues of teeth removed from each of the cases in this series showed extensive necrosis.)

Other teeth which were involved extensively and loosened by infection were removed at the time of the unroofing operation. Certain of the teeth removed at that later date might have survived the infection (Wassmund, Hesse, Frey).

The treatment of suppurative osteomyelitis of the mandible in children presents certain problems, which will be dealt with in separate communication.

TABULATION OF CASES

No. Age, Sex	Duration before surgical treatment	Extent of osteomyelitis	Treatment			Results
			Acute stage (1-3 weeks)	Duration of osteo- myelitis before major operation	Chronic stage (1 or more weeks)	
1 11 M	3 wks	Outer plate, from angle of jaw to first bicuspid	Abscess incised 3 teeth extracted	20 days	Outer plate removed Alveolus trimmed. Gums approximated. Jaw immobilized 3 weeks	Osteomyelitis healed 1 month after operation. Function and occlusion excellent. Follow-up 6 months
2 27 M	12 ds	Outer plate, from mandibular to mental foramina. Pathological fracture below third molar	Abscess incised, 3 teeth extracted	21 days	Outer plate removed. Alveolus trimmed. Gums approximated. Jaw immobilized 3 months	Osteomyelitis and fracture healed 4 months after operation. Function and occlusion excellent. Follow-up 13½ months
3 31 M	15 ds	Outer plate of ramus and body posterior to second bicuspid	Abscess incised	26 days	Outer plate removed. 3 molar teeth extracted. Alveolus trimmed. Gums approximated. Jaw immobilized 3 weeks	Patient discharged against advice 3 weeks after operation. Gums healed, external drainage good. Condition excellent. Follow-up impossible (Military evacuation)
4 3 M	2 wks	Outer plate of body from angle of jaw to locotor region	Abscess incised 3 teeth extracted	33 days	Outer plate removed. 3 teeth extracted. Alveolus trimmed. Gums approximated. Jaw immobilized 3 weeks	Patient discharged against advice 9 days after operation. General condition excellent. Follow-up impossible. (Military evacuation)
5 24 F	3 wks	Infected radicular cyst. Osteomyelitis outside of cyst wall		21 days	Outer plate removed. Bicuspid and canine teeth extracted. Alveolus trimmed. Gums approximated	Osteomyelitis healed 5 months after operation. Function excellent. Follow-up 11 months
6 24 F	20 ds	Outer plate, from angle to mental foramen. Pathological fracture in bicuspid region. Alveolar processes	Abscess incised	3 mo	Outer plate removed. Molar and bicuspid teeth extracted. Necrotic alveolus removed. Gums approximated. Jaw immobilized 3-4 weeks	Fracture and osteomyelitis healed 3 months after operation. Function and occlusion excellent. Follow-up 6 months
7 18 M	4½ mo	Facial and lingual plates, from mandibular to mental foramina. Two pathological fractures		4½ mo	Both necrotic plates removed. Molar and bicuspid teeth extracted. Necrotic bone removed. Alveolus trimmed. Gums approximated. Jaw immobilized 1 month	Osteomyelitis healed 1½ months after operation. Fractures healed 3 months after operation. Function and occlusion excellent. Follow-up 8 months
8 12 M	yrs	Both plates of anterior part of ramus and postero-superior part of body healing. Pathological fracture		2 yrs	Necrotic bone removed. No extractions. Teeth quite solid. Jaw immobilized 6 weeks	Osteomyelitis and fracture healed 9 months after operation. Function and occlusion excellent. Follow-up 7 months

and become solid, if they had been allowed to remain intact for several months,—but they would have demanded root canal therapy. It is still a debatable point whether or not root canal therapy is ever indicated in multi-rooted teeth. Nevertheless, it was believed that maintenance of those teeth would have delayed healing of the underlying bone (Haupl) and that, since the sockets of the infected teeth could not be drained satisfactorily, removal of the teeth was indicated to prevent development of chronic foci of infection.

It was difficult to determine an exact time for the removal of necrotic bone and the establishment of thorough drainage. In cases of partial necrosis of the mandible, the time varied in individual cases according to the virulence of the infection. In most of the cases in this series the general and local symptoms began to subside after 10 days and after 21 days the condition was definitely subacute or chronic, at which time the

danger of a major operation was greatly minimized. At operation it was possible, by gross inspection alone, to distinguish the involved from the uninvolved bone. In one case, because the patient failed to return for treatment, the major operation was performed 4½ months after the onset of the disease, and at that time a fairly solid involucrum had been formed by the periosteum of the lingual plate. It was our impression, from experience in the other patients who were operated upon at an earlier stage, that the early operations prevented direct extension of the disease and thereby prevented extensive necrosis of the lingual plate of the bone. It is our conviction that adequate drainage of the medullary bone of the mandible cannot be obtained through small external openings such as are made during the acute stage and therefore unnecessary delay in the unroofing operation will favor extension of the disease.

In the major operation the wide external incision was chosen for the purpose of obtaining complete dependent drainage. It was our plan to remove all necrotic bone and any portions of the living bone which overhung the necrotic area. Usually the necrosis was present in the facial wall of the ramus or body of the mandible between the mandibular and the mental foramina. The upper portion of the ramus and the facial wall between the mental foramen and the symphysis mentis usually escaped without necrosis. In most instances the bone of the lingual plate showed less necrosis than that of the facial plate.

In 4 of the cases a portion of the lingual plate of the mandible also was necrotic and therefore there were definite pathologic fractures. In 3 of the cases showing pathologic fracture, there was only a narrow transverse area of necrosis of the lingual plate (the facial plates, however, showed extensive necrosis) and, therefore, even though involucrum had not yet formed, it was possible to remove all necrotic bone without danger of displacement of the fragments. In the fourth case both facial and lingual plates were necrotic from the lateral incisor to the third molar teeth but since the major operation had been performed 19 weeks after the onset involucrum had formed sufficiently to allow complete sequestrectomy to be carried out. The pathologic fractures were treated by immobilization of the lower jaw by means of interdental splints and wires. In these cases, as well as in 2 other cases not included in this report the fractures healed solidly in good alignment and the occlusion of the remaining teeth was satisfactory.

In the future we plan to remove the necrotic facial plate as soon as possible after the subsidence of the acute infection (i.e. 21 or more days after the onset). At that time if the lingual plate is uninvolved except for a small transverse area of necrosis with pathologic fracture (i.e. a narrow transverse area of necrosis extending from the alveolar process to the inferior border of the bone) the method as described shall be carried out in detail. On the other hand, if massive involvement of the lingual plate is encountered after removal of the necrotic facial plate, the lingual plate shall be left intact in order to preserve the shape of the jaw during the time when involucrum is forming in the inner layer of the periosteum. If the involved portion of the lingual plate undergoes complete necrosis, it can be removed by a second operation at a later date (after 3 or 6 months).

In the cases of suppurative osteomyelitis of the mandible (old series) treated by previous methods,

draining sinuses within the month were usually present. These sinuses were the result of incisions, extraction of teeth, or spontaneous drainage around the sides of the affected teeth. It is impossible to estimate the ill effects resulting from the ingestion of the pus over a period of many months. We believe that the osteomyelitis was prolonged by reinfection with mouth organisms,—a direct result of the communications between the oral cavity and the bone. Even though this danger may be more apparent than real, it seems advisable to eliminate it whenever possible. From the standpoint of the patient, drainage of pus into the mouth is one of the most undesirable features of the disease. For these reasons and also to shorten the period of healing of the bone the sinuses leading into the oral cavity were closed. No severe post-operative reactions or complications followed this procedure.

During the healed stage the only complaints were of slight tenderness of the operative scar, in 3 cases. The patients noted the discomfort only while lying with that side of the face against a pillow. Plastic operations were advised for the purpose of removing the scar.

The method described in this paper follows certain of the basic principles which have been emphasized by H. Winnett Orr for the treatment of osteomyelitis of long bones. These principles of management include (1) wide incision (2) unroofing of bone (3) leaving the wound wide open (4) vaseline gauze dressings and (5) immobilization of the part. In applying these principles to osteomyelitis of the mandible, it was necessary to modify many of the details of technique. These details have been outlined in the preceding paragraphs. The Orr principle of noninterference with the wound was not followed, chiefly because of the great amount of drainage which necessitated frequent change of dressings. In all of the cases in our recent series the bone healed promptly and the wound reacted just as it does ordinarily after operations for osteomyelitis of the long bones. Following the unroofing operation, there was no extension of infection into the uninvolved bone. Wide incision and complete exteriorization of the infected area were the factors responsible for the prevention of this dreaded complication.

SUMMARY

1. A review and a discussion of the surgical treatment of osteomyelitis of the mandible is presented.

2. A method of management for the chronic stage is described. The method embodies the following steps:

a. Removal of the necrotic outer plate of the mandible as soon as possible during the early chronic stage (i.e., 21 days after the onset) The necrotic bone is removed through a wide external approach and may be excised before it has separated spontaneously in the form of a sequestrum. In case of massive necrosis of both plates of the mandible sequestrectomy is delayed until involucrum has formed

b. Removal of teeth over the area of osteomyelitis. These teeth are always loose and bathed in pus and in most instances their pulp tissue is necrotic.

c. Exteriorization of the tooth sockets and partial resection of the alveolar process with complete closure of the gum margins to prevent further drainage of purulent material into the oral cavity

d. Immobilization of the jaw

3. The results of 8 cases treated successfully by the new method of management are presented. The results have been very encouraging and, we believe, superior to those obtained by the more conservative treatment.

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AN EXPLANATION OF PROLONGED LABOR IN CASES OF OCCIPITOPOSTERIOR POSITION

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THE opinions of obstetricians concerning the significance of occipitoposterior positions are generally not in accord. Several European authors, for instance, attach no special importance to this condition, because, according to their experience it does not as a rule, seriously interfere with labor. Other writers, notably American, however, consider the management of occipitoposterior position during labor a task of great responsibility and one requiring active treatment. The latter view is held for the most part by those obstetricians who display a tendency toward interference and prefer to terminate labor when dilatation of the cervix is complete. They will observe the condition frequently because they will encounter occipitoposterior positions in cases in which anterior rotation of the small fontanelle would have occurred spontaneously after a lapse of time.

In my opinion, the high incidence of 30 per cent of occipitoposterior positions during labor reported by Bill are possibly to be explained thus.

In contradistinction to the overestimation of the importance of occipitoposterior position, there are obstetricians who consider that this position exerts no effect on the course of labor. This view is obviously erroneous. I am entirely in accord with the views of Bland and DeLee regarding the significance of occipitoposterior positions in labor.

In my experience, the great majority of cases of labor with posterior occipital positions terminate spontaneously although some delay is to be expected. Occasionally, however, considerable difficulty arises which requires interference.

Though several authors mention that occipitoposterior position causes decided prolongation of labor (Bill, Bland, Danforth, DeLee, and Williams) I must emphasize that in my experience it is mainly the *first stage* which is lengthened. According to Jauchke, the second stage is the one essentially prolonged. Prolongation of the second stage, however, is not significant in itself since it results either from exhaustion of the uterine musculature produced by an extended first stage or from the non-engagement or tardy descent of the occiput into the pelvic cavity.

Attention should here be directed to these two complications, requiring careful consideration,

namely prolongation of the first stage and tardy descent of the head. In my series of cases these complications occurred in 20 to 25 per cent of occipitoposterior labors. All of us can recall cases in which the head is floating, the membranes are ruptured, and dilatation of the cervix is progressing slowly. Occasionally labor comes to a standstill in these cases. If at this point vaginal examination is made, the small fontanelle will be found in many cases in the posterior quadrant of the pelvis. If the obstetrician, however, does not appreciate the delay in labor or fails to attach any special significance to it, and postpones vaginal examination, he will be unable to diagnose the condition later because of the development of a large caput succedaneum. Yet the posterior rotation of the presenting part may be the sole cause of the delay.

I have been unable to find in the available literature any explanation of the lack of proper descent of the head into the pelvic cavity in certain cases. I have, therefore, sought its explanation since it cannot be attributed entirely either to primary inertia or to ineffective uterine contractions.

It is well known that the anterior wall of the bony pelvis (the os pubes) is much lower than the posterior wall formed by the hollow of the sacrum. As the head traverses the pelvis in the direction of the so called pelvic axis, all points of the presenting part do not advance an equal distance. The part nearer the pubic arch reaches the outlet sooner than that approaching the sacrum. The situation resembles the bend in a circular race course where the competitor on the inner side has a shorter distance to travel. In occipito-anterior positions the small fontanelle is in the anterior part of the pelvis and after a descent of only a few centimeters reaches a point deep in the pelvic inlet (Fig. 1). On the contrary if the small fontanelle is in the posterior section of the pelvis (occipitoposterior position) the head will not have engaged in the inlet after traversing the same distance (Fig. 2). Obviously if the small fontanelle is in the posterior quadrant of the pelvis the course of labor will be more difficult. The difficulty will be relatively insignificant if uterine action is vigorous or if the head is small in comparison with the pelvic diameters.

This is verified by the experience of most authors. Jaschke for example mentions that occipitoposterior position "fortunately occurs almost exclusively with small dead or premature fetuses."

In this way it can be explained why in certain cases of occipitoposterior position the head fails to descend into the pelvic canal or its descent is delayed. My explanation applies solely to the progress of labor in occipitoposterior position and does not touch upon the theories concerning the mechanical factors of the etiology of this anomaly (Sellheim, Mueller, Zweifel, Kehrer Lahm, Porter, Fekete)

The question arises what should be the procedure in cases in which the small fontanelle is in the posterior half of the pelvis and descent into the pelvic cavity is retarded. It need not be emphasized that the only correct attitude is that of careful observation since in the majority of cases spontaneous delivery ultimately occurs. I am, therefore, opposed to the view of surgical intervention when the cervix is fully dilated. Such a procedure would cost many maternal and still more fetal lives.

However, if the labor is definitely delayed and the small fontanelle is located in the posterior quadrant of the pelvis in the absence of other abnormalities (disproportion inertia, etc.) anterior rotation of the occiput should be aided by other means. At the onset of labor a change of posture such as knee-chest or lateral recumbent position may be of advantage. At the completion of the first stage, anterior rotation of the head should be effected by manual rotation. This procedure has proved efficacious especially in multiparae in my personal cases, as well as in those reported by Bland. Manual rotation is often followed by rapid descent of the head into the pelvic cavity.

It should be stressed here that it is not necessary to rotate the occiput until it reaches the anterior termination of the oblique diameter. It is often observed that after a slight manual movement the occiput rotates spontaneously during the next few pains.

Of course, it is to be expected that in a proportion of cases, labor will require termination by forceps. It is not my purpose here to deal with this type of case, but merely to present the ex-

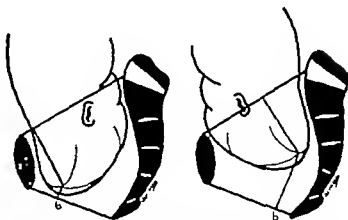


Fig 1 left Occipito-anterior position

Fig 2 Occipitoposterior position Explanation a, The distance of the point of direction from the inlet in both cases equal b The distance of the point of direction from the outlet on Figure 2 considerably longer

planation of the mechanism of labor and to point to its practical application. I should like to mention that if the head is in or near the outlet and termination of labor is indicated because of maternal or fetal reasons, forward rotation of the small fontanelle with the Kielland forceps should be attempted. This should not be forced, and if it is easier the head should be delivered in the occipitoposterior position.

One point which merits brief consideration is the question of vaginal examination. One should not hesitate to employ it when the necessity of correct diagnosis is at hand. Although needless vaginal examinations may court disaster, omission of it is likewise fraught with danger when it is necessary to obtain a clear picture of the situation. Though vaginal examination is regarded as an operation on account of inherent dangers, in certain cases performance of it is imperative. Internal examination performed with skill and strict adherence to the rules of sterility (preparation of patient, scrubbing of hands sterile rubber gloves) will make possible early recognition of certain anomalies (moderate disproportion occipitoposterior position, etc.), without danger to the parturient patient. Bearing these in mind the obstetrician will attend the case with special care, and in this way many children may be saved who otherwise would have died as victims of excessive conservatism.

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In this way it can be explained why in certain cases of occipitoposterior position the head fails to descend into the pelvic canal or its descent is delayed. My explanation applies solely to the progress of labor in occipitoposterior position and does not touch upon the theories concerning the mechanical factors of the etiology of this anomaly (Sellheim, Mueller, Zweifel, Kehrer, Lahm, Porter, Fekete).

The question arises, what should be the procedure in cases in which the small fontanelle is in the posterior half of the pelvis and descent into the pelvic cavity is retarded. It need not be emphasized that the only correct attitude is that of careful observation since in the majority of cases spontaneous delivery ultimately occurs. I am, therefore, opposed to the view of surgical intervention when the cervix is fully dilated. Such a procedure would cost many maternal and still more fetal lives.

However, if the labor is definitely delayed and the small fontanelle is located in the posterior quadrant of the pelvis, in the absence of other abnormalities (disproportion, inertia, etc.) anterior rotation of the occiput should be aided by other means. At the onset of labor a change of posture such as knee-chest or lateral recumbent position may be of advantage. At the completion of the first stage, anterior rotation of the head should be effected by manual rotation. This procedure has proved efficacious especially in multiparae. In my personal cases, as well as in those reported by Bland, manual rotation is often followed by rapid descent of the head into the pelvic cavity.

It should be stressed here that it is not necessary to rotate the occiput until it reaches the anterior termination of the oblique diameter. It is often observed that after a slight manual movement the occiput rotates spontaneously during the next few pains.

Of course, it is to be expected that in a proportion of cases, labor will require termination by forceps. It is not my purpose here to deal with this type of case, but merely to present the ex-

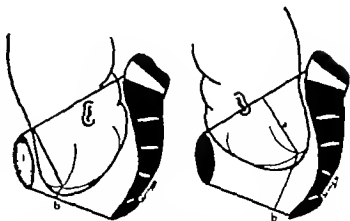


Fig. 1. left. Occipito-anterior position.
Fig. 2. Occipitoposterior position. Explanation: a. The distance of the point of direction from the inlet in both cases equal. b. The distance of the point of direction from the outlet on Figure 2 considerably longer.

planation of the mechanism of labor and to point to its practical application. I should like to mention that if the head is in or near the outlet and termination of labor is indicated because of maternal or fetal reasons, forward rotation of the small fontanelle with the Kielland forceps should be attempted. This should not be forced and if it is easier, the head should be delivered in the occipitoposterior position.

One point which merits brief consideration is the question of vaginal examination. One should not hesitate to employ it when the necessity of correct diagnosis is at hand. Although needless vaginal examinations may court disaster, omission of it is likewise fraught with danger when it is necessary to obtain a clear picture of the situation. Though vaginal examination is regarded as an operation on account of inherent dangers, in certain cases performance of it is imperative. In ternal examination performed with skill and strict adherence to the rules of sterility (preparation of patient, scrubbing of hands, sterile rubber gloves) will make possible early recognition of certain anomalies (moderate disproportion, occipitoposterior position, etc.), without danger to the parturient patient. Bearing these in mind the obstetrician will attend the case with special care, and in this way many children may be saved who otherwise would have died as victims of excessive conservatism.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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AUGUST 1934

CARL ARTHUR HEDBLOM

CARL ARTHUR HEDBLOM professor of surgery at the University of Illinois College of Medicine and for many years a member of the editorial staff of the *International Abstract of Surgery* died suddenly after an illness of less than forty-eight hours while attending the meeting of the American Surgical Association in Toronto June 6 1934. His untimely going is mourned by a devoted wife by three sons and a daughter by a mother now in her ninety-second year by a brother and six sisters and no less by his colleagues in the surgical profession both in America and abroad by his associates in the College of Medicine and by a host of grateful patients in the many centers to which his varied and active career carried him.

Dr. Hedblom one of the youngest of eight children was born of Swedish parents in Dayton Iowa March 5 1879. In spite of lack of encouragement and even opposition on the part of his parents he determined to follow the practice of medicine. After receiving the degree of bachelor of arts from Colorado College in 1907 he entered Harvard Medical

School and was graduated in 1911. Just before the close of his two years' service as interne and resident at the Massachusetts General Hospital he was married to Eleanor Pease. Shortly afterward he received the appointment of professor of surgery in the Harvard Medical School of China at Shanghai. There as throughout his life work seemed to crowd upon him and the demands of a rapidly increasing private practice together with the work of the department of surgery of the medical school seemed almost too great even for his abundant energy.

In 1916 he returned to America and became first a fellow in surgery at the Mayo Clinic and soon afterward an active member of the surgical staff. From 1919 to 1924 he was head of a section on general surgery and of the department of thoracic surgery at the Mayo Clinic. His thesis on chronic empyema published in the *Annals of Surgery* in September 1920 and based on the studies in recognition of which he was awarded the degree of doctor of philosophy by the Mayo Foundation of the University of Minnesota is the most scholarly and comprehensive presentation of that subject in American surgical literature.

In 1924 he left the Mayo Clinic to become professor of surgery at the University of Wisconsin Medical School at Madison and two years later was appointed professor of surgery at the University of Illinois College of Medicine. In Chicago he gathered about him a group of earnest young men at the new Research and Educational Hospital and there began to build up a department of surgery upon a sound foundation of serious surgical research clinical teaching and investigation.

phrenic nerve. In Group I patients aspiration of pus and replacement with a gradually decreasing amount of air should check the formation of pus and cause full expansion of the lung in a high percentage of cases. If this should not occur, an extrapleural thoracoplasty should be performed. In Group III patients the same treatment should be used. Sufficient air, however, should be introduced after each aspiration to keep the actively tuberculous lung collapsed if collapse is indicated. Obliterative pleuritis often causes forced expansion of the lung and loss of the pneumothorax. Oleothorax may be used to prevent this but in the majority of cases with obliterative pleuritis an extrapleural thoracoplasty must be used to maintain pulmonary collapse.

Attempts to kill the pyogenic organisms in Group II cases with repeated aspirations and antiseptic instillations or irrigations should not be persisted in for more than a few days in toxic patients because such efforts usually fail. An encouraging temporary remission in the severity of the symptoms and temporary disappearance of culturable pyogenic organisms are frequently all that is accomplished. Air tight or open tube drainage should be used according to the specific indications. Prolonged tube drainage with antiseptic irrigations results in complete expansion of the lung and obliteration of the empyema cavity in some cases of mixed tuberculous empyema. The majority, however, eventually require extrapleural, or extrapleural and Schede thoracoplasty to close the empyema completely even if the lung need not be collapsed.

The object of treatment in Group IV is to evacuate the pus, sterilize the cavity, and maintain collapse of the diseased lung. Treatment is virtually the same as for Group II except that a thoracoplasty should be performed if not contra indicated before drainage results in a harmful degree of expansion of the lung.

The general briefly outlined plan of treatment is, of course, subject to many necessary modifications because of such special factors as age of the empyema, unusually mild or severe infection, poor condition of patient, hopeless bilateral cavernous pulmonary or other tuberculous pleurocutaneous sinus or bronchopleural fistula with or without vomica.

Individualization in applying the available procedures is capable of producing far better results than the routine exclusive use of aspiration or drainage or thoracoplasty. In a group of 70 consecutive tuberculous empyemas, 69 of which had mixed tuberculous and pyogenic infection or active pulmonary tuberculosis, or both, and 17 of which had bronchopleural fistula, 61.4 per cent are cured (solidly closed empyema without sinus, and no tubercle bacilli in the sputum or no sputum), 32.9 per cent are dead. It is significant that only 2 of the 23 deaths were directly, and only 6 perhaps indirectly connected with a surgical operation, the other deaths were due chiefly to continuing progression of pulmonary tuberculosis principally in the contralateral lung. Thoracoplasty was used in 45 of the 70 patients, 80 per cent of whom are cured.

The widespread prejudice among internists against surgery is based first upon the poor results that occur when the patients are not referred for operation until they have become extremely toxic, and second upon the poor results that occur when surgical drainage is not efficient and when extrapleural or Schede thoracoplasty has not been planned to assure complete closure of the empyema cavity.

Attainment of the best results depends chiefly upon recognition of the importance of distinguishing between the four distinct types of the disease and upon a high degree of individualization in applying the various therapeutic measures that may properly be used in each type. JOHN ALEXANDER

MASTER SURGEONS OF AMERICA

ARTHUR AYER LAW

OVER the last resting place of one of nature's truest gentlemen, one of her brightest, happiest spirits, one among the most brilliant, the most helpful saviors of suffering men and women, stands a headstone which bears the following inscription:

ARTHUR AYER LAW

Soldier—Surgeon

Born April 16, 1872—Died, July 9, 1930

It may be aptly said of Dr. Law that "Whom the gods love die young." For he was surely one whom the high gods loved. And he was one of whom it was true that his days were foreshortened by the strenuous pressure under which he lived them.

Handsome of feature and of form, consciously upstanding among his fellows, favored of birth, of family, and of fortune, he went through life admired of his friends, beautifully devoted to his nearest and dearest, lovers, blessing and blessed in his home companionships, keenly alive to the beauties of art, music, and literature, faithful to his professional associates, appreciative of their personal friendship, and giving them freely of his own, taking his forward place among them as of right, and according to them theirs, on equal terms.

Had he lived less intensely, he might have lived longer, but he would not have lived in the full enjoyment of life as he did; he would not have been the Arthur Ayer Law that he was.

His creed was written in the glorious lines of William Cullen Bryant, which he loved:

A mighty hand, from an exhaustless urn,
Pours forth the never-ending flood of years
Among the nations,
Its rushing waves bear all before them,
On its foremost edge,
And there *alone* is Life.

He drained that flowing cup of life forever at the brim. It filled his soul with that elixir of joy—the incomparable joy of living that made his native atmosphere.



ARTHUR AUER LAW
1872-1930

MASTER SURGEONS OF AMERICA

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ARTHUR AYER LAW
1872-1930

He was a Britisher, not by birth but by blood by a long line of English ancestry, by the choice heritage of traits characteristically Celtic. And yet he was a loyal American who translated into the terms of democracy the principles of Runnymede and the pride of his Anglo-Saxon race.

His forbears had served for generations in the army and navy of Great Britain. An uncle, officer in the Royal Welsh Fusiliers, had been killed at the Relief of Lucknow, as "the Pipes of Scotland played." Another uncle had died in service in Australia, and a third had gone down fighting in China. His father, Arthur Ellenborough Law, but recently dead, had served for several years as a British midshipman. He came to America aboard the famous clipper ship *The Flying Cloud*. He settled in Illinois where, at Harvard, this boy of his, Arthur Ayer Law, was born. Railroading by occupation, the father from his boyhood up, remained a skilled violinist. His music teacher, who played in the old Shakespearean theater in London, now and then allowed his young pupil to play in his place in the orchestra.

Arthur's mother, daughter of the late Judge Eldridge Ayer, a civil war patriot, is still living at over eighty years. She was an accomplished pianist and she recalls how she and his violin-loving father oftentimes put Arthur to sleep to the operatic strains they would play together. Both of them bestowed upon the boy his life-long love of music.

Arthur Ayer Law was especially interested in the history of his paternal grandfather, Henry Law. Born in Glasgow, educated at the University of Edinburgh, Dr. Henry Law subsequently became a Fellow of the Royal College of Surgeons and practiced his profession abroad. Forsaking his surgical work in later life, he owned and directed a line of merchant marines plying between England and the Orient.

With such a heredity and such a family history, it was little strange that Arthur Ayer Law should have begotten a taste for that intensity of living which characterized him in all he did, with that habitual love of adventure and with his actual propensity for war and the discipline of war which he carried into all his years. He was an exemplar of the hereditary theorem of Hergesheimer: "That I am,—that I was before I was born."

It is probable that his later love of war service was stimulated by his school education at the Shattuck Military Academy in Faribault, Minnesota.

In his boyhood and youth he cultivated a love of the great out-of-doors, living much at Lake Geneva, in Wisconsin, a picturesque spot where he roamed the woods with his rifle, bringing down now a squirrel, a rabbit, or a bird, upon which he demonstrated, in anticipation of his future professional tastes, the study of comparative anatomy.

Following his sport-loving tendencies, he distinguished himself in the hunting of big game in the Bitter Root Valley and in the North Woods neighboring upon his

summer camp. The rod and reel had an especial lure for him and he found much of his recreation in whipping the wild streams of Minnesota for the speckled trout.

All these experiences entered into his keen worship of nature, twin of his appreciation of both art and music. Alike they served as the media of contact, with the world about him of his exceptionally receptive mind.

As a student in the medical school of the University of Minnesota, whence he graduated in 1894, and in his early teaching of surgery he proved the ready adaptation of his mental faculty to practical use and power. He was recognized when a very young surgeon as a keen diagnostician and a brilliant operator.

Hardly had he entered upon his surgical career in association with Dr. Frederick A. Dunsmoor of the university staff before his inherited tendencies invited him into the theater of war. The outbreak of the conflict between the United States and Spain, in 1898, intrigued him with a call he could not resist. He enlisted with the rank of first lieutenant and assistant surgeon and later was promoted to the captaincy of the Thirteenth Minnesota Regiment. The early enrollment of this regiment was the second unexampled response of his State to the need of the country at war. He with his command was ordered to the Philippines, where he fought in the Battle of Manila, August 13, 1898, against the Spaniards. After policing the City of Manila for several months his regiment, the Thirteenth Minnesota, was ordered out to guerrilla warfare against Aguinaldo and his insurrectos. In September, 1899, his regiment was ordered home and after a parade in Minneapolis Captain Law riding with the field and staff officers, at the head of his men, he was mustered out in Saint Paul in October, 1899.

Arthur Ayer Law's already announced engagement to Helen E. Lougee culminated in their marriage in November of 1899. She and their two daughters, Elizabeth Law Fullerton and Mary Ayer Law Webb, survive him. The strong family sense born and bred of an English heritage into their American home proved the ideal quality of companionship alike in their marriage and their parenthood. He was in love with his girls as with his wife. Whether at home or abroad he was never so happy—and happiness was his normal habitus—as when his home companions were with him.

In the year 1918 he was tempted away from his home and his busy life—and again in the service of his country. With the opening for the United States, of the World War Base Hospital No. 26 was jointly organized and equipped by the University of Minnesota Medical School and the Mayo Clinic of the City of Rochester. Dr. Arthur Ayer Law was placed in command, with the rank of major, being promoted later to lieutenant colonel. He took an active part in the preparation of the Base Hospital, organizing it in Minneapolis and providing much of its equipment from contingent funds contributed for the purpose. He was later appointed a member of the Medical Council of National Defense.

In June, 1918, he was ordered to take Base Hospital No. 26 overseas. It was stationed at Allery in the Department of Saône-et-Loire. It did well and nobly.

its share in the medical and surgical service of the War as did all the Base Hospitals of the United States. It was ordered home in 1919. Later he received the coveted citation of the United States Government.

He had no illusions as to the causes and the results of the Great War. He put the whole burden of it where he believed it belonged. He looked all questions squarely in the face. He was a man without compromises and free of excuses for himself and equally so for anybody else. Its experiences entered into the very spirit of the man but he was glad that his country was in the war and he with it.

He returned to his home and to his work with the same but a tempered spirit of joy. That joy had always expressed itself in service and it did so still. He resumed his allegiance to the University of Minnesota Hospital, the Glen Lake Sanatorium for the Tuberculous and the Northwestern Hospital of Minneapolis.

In his practice he was governed as he had always been by but one consideration—the welfare of his patients.

Upon the teaching staff of the University of Minnesota in its undergraduate and graduate medical faculties, he had risen in the ranks, from an assistant in surgery, to an instructor, and then to an associate professor of surgery.

In his profession at large he gave himself unsparingly to the support of the American Medical Association, the American Surgical Association, the American College of Surgeons (regent, 1923-1925, founder), the Western Surgical Association, the Southern Surgical Association, the Inter State Post Graduate Medical Assembly of North America, the Southern Medical Association, the Minnesota State Medical Association, the Southern Minnesota Medical Society, the Minnesota Academy of Medicine and the Minneapolis Surgical Society.

He was a member of all the principal social clubs of his city and of the American Legion.

He was not a prolific writer and he sought conservative channels of publication. Nevertheless he was a steady contributor to the literature of his profession. In the quarter century of his active practice he issued fifty or more articles in the professional press. Those among them all in which he took the greatest satisfaction were his contribution to "The Master Surgeons of America," in the review of the life and work of his educational chief, Dr. James Edward Moore and his two brief histories of Base Hospital No. 26. His bibliography of strictly surgical subjects, while not extensive, was as wide as the field of surgery itself. Among its topics are notable additions to the surgical story of his times.

His life long allegiance to the Episcopal Church was a matter of inheritance, as well as of choice. It was an expression of his love of beauty in word as in spirit—a testimonial to his religious taste for order and good form in worship and in ritual. He was a consistent member of Saint Mark's Episcopal Church in his home city. From within its lovely walls and under its age-old beautiful rites he was borne to his burial.

RICHARD OLDING BEARD

EARLY AMERICAN MEDICAL SCHOOLS

ILLINOIS' FIRST MEDICAL SCHOOL

CARL E. BLACK, A. M. M. D. F. A. C. S. JACKSONVILLE, ILLINOIS

ILLINOIS was only ten years old when Illinois College (1829) began the instruction of its first classes. It is the oldest college in Illinois. It is difficult to visualize the conditions under which this school was established. It was opened for teaching just ten years after the first settler built his cabin in Morgan County and only four years after the town of Jacksonville was incorporated and became the county seat. In those four years over 600 settlers came in to make it their home. An unusual proportion of these new settlers were from Kentucky and Virginia, and from New England, and had enjoyed educational advantages and they joined forces in establishing a college, and made their settlement one of the most important in the new state.

By 1840 the town had a population of twenty-five hundred and the trustees of the College planned to establish departments of medicine, law, and theology.

Samuel D. Lockwood, the first chief justice of Illinois, and Joseph Duncan, the fifth governor of Illinois, were members of the Board of Trustees. The Civil War governor, Richard Yates, was in the first graduating class from the liberal arts department. The school of medicine began its course of lectures November 1, 1843, although, as

was customary in this pioneer country, some members of its faculty had been taking students for several years. It was the evident intention of the trustees to have opened the medical department earlier but there was difficulty in arranging its housing. It was finally housed in the attic of Beecher Hall. Looking at these low attic rooms today it seems almost impossible that any kind of a school could have been housed there. The pioneer seemed to thrive on difficulties and inconveniences and the attic did not appear so impossible to him as it does to us today.

Beecher Hall is still in good repair and houses the two oldest college literary societies (for men) in Illinois.

By its third year the medical school was provided with a new building. This was a plain, two-story frame building and at the time was considered quite commodious. There was a small room under the stairway which was known as the "Salt Pork" room. In other words, the dissecting material from the neighboring cemetery which was only half a mile away was stored here.

Prior to 1843, 26 medical schools had been organized in the United States and 10 of them were in the Mississippi Valley. Six were organized in 1843. Half of the Valley schools were in Ohio.



David Prince



Daniel Stahl



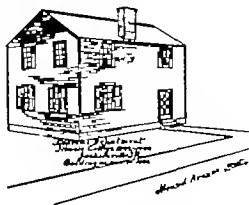
Henry Wing

2 in Kentucky 2 in Missouri, and 1 in Louisiana. Two medical schools began their teaching in Illinois in 1843. The Illinois College School antedated Brainard's (Rush Medical College) School by a month—December 4, 1843.

The first catalog of the Illinois College School announced "The course of lectures commences annually on the first of November and continues sixteen weeks. The cost of tickets to the full course of lectures is \$60.00 tickets for private dissection, \$5.00 graduation fee, including diploma, \$10.00.

The first two presidents of the College, Edward Beecher and Julian M. Sturtevant, were clergymen and a number of the trustees were clergymen. They were members of the "Yale Band" and were really educational missionaries in the pioneer West. In New England they were known as the "Illinois Band." The trustees felt the urge of the missionary spirit when they announced to the medical department, that students preparing for a missionary life, and wishing to pursue medical studies for that purpose are admitted to the lecture free of expense." While there is no record that the medical faculty complained of this arrangement, it was a little hard on them as they received all fees to cover their services but they carried the entire expense of the medical school including rent, in exchange for the use of the medical building.

One of the requirements for the degree of doctor of medicine is especially interesting at this date. The catalog provided that "he (the student) must pass a satisfactory examination in all the branches of medical study before the Medical Faculty, assisted by a Board of Censors, annually appointed for that purpose by the trustees. It was not always possible in the pioneer country to



Medical Department, Illinois College, 1842-1848

secure a board of "Censors," all of whom had the degree of doctor of medicine. The trustees were equal to the emergency, and conferred an honorary M.D. on these in order that the "Board of Censors" should be properly accredited. However, no harm was done as the list of censors shows that care was taken to secure practitioners of standing regardless of their deficiency in medical school training.

A catalog of the medical school was issued in January 1848, but as far as we have been able to learn no medical classes were held after the spring of 1848. Just why the project, which had so satisfactory a beginning was so abruptly and unceremoniously discontinued does not appear. There is no record of the existence of debt incurred by this department. There was only one other medical school in Illinois, and that far away in Chicago. Compared with other departments, this one had by far the largest attendance and its students paid the largest fees and were in attendance the shortest time. Considerable money had been spent for a building. A good medical library and



Samuel Adams



Henry Jones



Edward Mead



"Old Beecher," the first college building erected (1829) in Illinois, now used as a home for literary societies of Illinois College, was the home of the first medical school in Illinois.

apparatus had been provided. In this school as in many others of its day there was a serious conflict between the liberal arts faculty and the sciences, even in medicine. There was a great repugnance toward the men who practiced in the dissecting room.

Doctor David Prince, the professor of anatomy and surgery, was an enthusiastic follower of John Hunter and especially of his preceptor and former associate Reuben D. Munsey. Dr. Prince believed that every physician should be well grounded in anatomy and the only way to acquire this knowledge was in the dissecting room. Dr. Prince saw to it that material for dissecting was provided, but he was evidently not careful about the feelings of the literary faculty or of the community in obtaining it.

Looking back at the situation in 1848, it seems probable that the "anatomy question" was the significant cause for the discontinuance of the medical department. No doubt the fact that the medical faculty bore all the expense, and often took their pay in student notes, had an influence.

An examination of the account book of Dr. David Prince during this period shows that he not only took notes from medical students but that he furnished a number of them dissecting material on credit, and also that in a number of instances, he furnished money for their board, books, and clothing. The books show also that in after years most of this money was paid back, often with interest. Considering the scarcity of cash, in those days it must have been a severe drain on the doctor's resources to make these

advancements. It would have been easier for the medical faculty if they had been supported by a better public opinion. The citizens had not yet learned that they had a moral and financial obligation in supporting professional education. The public wanted good physicians when sick but could not approve of the method by which the physician became efficient.

The following is a reproduction of the list of those who taught in the medical school, as it appears in the college catalog.

Accounts	Faculty
833	Chemia et Historia Naturalis Samuel Adams, M.D.
843	Medicinae, Theoriae et Praxis Daniel Stahl, M.D.
1845	Johannes James, M.D.
843	Anatomiae et Physiologiae David Prince, M.D.
845	Johannes Leland Miller, M.D.
843	Obstetrica Henricus Jones
1843	Materia Medica et Therapeutica Samuel Adams, M.D.
1845	Edwardus Mead, M.D.
847	Henricus Winst, M.D.
844	Chirurgiae et Chirurgicae Anatomicae Gulielmus B. Herck, M.D.
845	David Prince, M.D.
845	Chemia et Aetologiae Physicae Samuel Adams, M.D.
849	Sacrae Theologiae Johannes M. Stertevant, S.T.D. Praes.

In its last analysis, the planting of the medical school in the pioneer State of Illinois was a missionary effort. Doctors were needed in these rapidly developing but isolated communities. The

roads were bad and the most rapid method of travel was by horseback. Doctors could not travel far to their patients nor could the settler send far for a doctor. The Medical School was an effort to meet this situation. That this school assembled an unusually good faculty is attested by the future accomplishments of the young men

who composed it. All were excellent practitioners in after years, several achieved some national recognition and at least one became internationally known.

During its existence of five years there were 102 students in its classes and 30 men were graduated with the degree of doctor of medicine.



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In its last analysis, the planting of the medical school in the pioneer State of Illinois was a missionary effort. Doctors were needed in these rapidly developing but isolated communities. The

subjects. The author is privat-dozent in surgery and chief of the surgical clinic in Leipzig. A superficial survey of the literature had convinced him that knowledge of these two types of embolism still contained many uncertainties. He therefore has undertaken in this volume to present the most comprehensive picture possible of these two pathological conditions and to emphasize the problematical features of both subjects in order to stimulate further investigation. For this reason much attention is given to theoretical considerations. The two subjects are treated in separate parts instead of being welded together in one unit as he had originally hoped to do. While there are many points of contact between these two types of embolism the contact is essentially a loose one and not an organic union. To air embolism are assigned 132 pages to fat embolism 117 pages. The 9 pages remaining contain the bibliography with 950 titles on air embolism and 450 on fat embolism.

In order to bring some degree of variety into the inflexible material to be considered the author has, as far as possible chosen different arrangements for the two parts of the monograph. But even so, the outline of the two sections are very similar. Each part begins with chapters on 'definition and general characterization' of the respective pathological conditions, and on the 'history' of the development of our knowledge concerning them. These chapters are followed in each case by a long section on the general pathology, pathological anatomy and pathological physiology of air and fat embolism respectively, in which are considered such subjects as portals of entry conditions of entry course and further fate of the air or fat entering the circulation. The causes of death in each instance are discussed at some length. Almost 30 pages are devoted to the pathological anatomy and pathology of fat embolism. The second section of each part includes the clinical aspects of air and fat embolism with discussions of their etiology symptomatology diagnosis, prognosis, prophylaxis, and treatment.

Of the 50 illustrations, 6 are in colors. Of special interest are the roentgenograms showing the presence of air in the right side of the heart. The typography is excellent. The author has refrained from the German habit of using long involved sentences and has produced a volume that can be read without too much difficulty by anyone with a reasonably good knowledge of the language. There is no index, but the table of contents is so constructed that the page on which any special phase of either subject is discussed can be readily found. J. P. SIMONDS.

and half of the monograph is devoted to the injured child in which diagnosis, treatment, and prognosis are described. A number of illustrations are included many of which illustrate gruesome and preventable injuries during examination and extraction of the child such as are seldom observed in this country. The German literature is quoted solely in the preparation of this work. IRVING F. STEIN

VOLUME V of *The Practitioner's Library of Medicine and Surgery*¹ confines itself to traumatic surgery. It is a compilation of treatises by 17 authors several of whom are outstanding in their field, and includes surgical conditions resulting from direct or indirect injury. As in volume IV which deals with surgical conditions which are nontraumatic in origin this volume is aimed primarily for the general practitioner.

The chapter on fractures deserves especial commendation. In the limited space permitted, Professor Vossell has beautifully covered the tremendous field of fractures, a subject which ordinarily would cover several volumes. This chapter is exceedingly meaty all unnecessary facts having been eliminated. The chapter is profusely illustrated making this section of inestimable value to the practitioner.

The chapter on amputations by Thomas Orr is excellent, and should be of value to the specialist as well as to the general practitioner. Several types of amputations are described which have been more or less discarded but Orr probably included these for completeness.

One of the most enlightening chapters, and especially useful in this day of speed is that by Beck on "Traumatic Lesions of the Thorax and Thoracic Viscera." In this chapter the author covers the physiology of the pleura, lungs, mediastinum, pneumothorax, massive collapse of the lungs, traumatic asphyxia, wounds of the thorax, trauma to the mediastinum, wounds of the pericardium and the heart, as well as many other related conditions. This should be a most instructive adjunct to the average man, even though it be the work of a most experienced specialist.

Of interest to the man doing industrial surgery is the rather short but concise and instructive chapter on "Traumatic Neuroses." Interesting data is brought forth which should prove most valuable to the man engaged in this type of work.

The entire volume is clearly written, not too technical, well illustrated, and should most certainly be welcomed at this time. EARLE I. GREENE

NAUJOKS has adequately covered the field of birth injuries of the child in this brief monograph.² He first discusses the etiological factors, considers external trauma, pelvic contraction and anomalous fetal development as well as injury during spontaneous and operative deliveries. The sec-

THE author of *Laboratory Medicine*³ in his revision, has succeeded very well in his purpose of providing a suitable guide for both students and practitioners. The chapter guiding the practitioner in the choice of tests and the indications for these

¹THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY, Vol. V—TRAUMATIC SURGERY. New York and London: D. Appleton-Century Company, 1934.

²LABORATORY MEDICINE: A GUIDE FOR STUDENTS AND PRACTITIONERS. By Daniel Nicholson, M.D. 2d ed. Philadelphia: Lea & Febiger, 1934.

DIE GEBURTSVERLETZUNGEN DES KINDES. By Prof. Dr. Med. Hans Naujoks. Stuttgart: Ferdinand Enke, 1934.

tests is of especial value at this time when there is a noticeable tendency to require laboratory work without due consideration of its real value in diagnosis and treatment.

The subject matter is clearly presented and the charts and other illustrations well chosen. The most recent technical procedures are presented in detail in an unusually simple manner.

The type is large and clear and the index quite thorough. HOWARD K. NICOLL.

VOLUME VI of the system of medicine entitled *The Practitioner's Library of Medicine and Surgery* is a book of 900 pages on "Obstetrics and Gynecology."

Two-thirds of this volume is devoted to obstetrics, the remainder to gynecology. Fourteen men have contributed to the volume which was edited by Luther K. Musselman of Yale. The outstanding chapter in the volume is the one on the pathology of labor by Herbert Thoms. While Thoms points out the fallacy of relying on external pelvimetry for determining the probable outcome of a given case, and offers a rather accurate method of measuring the pelvic inlet by roentgenography, one can hardly agree with him that this is a necessary procedure in all primiparae.

Thoms omits a very important procedure in enumerating the various manual methods of attempting to determine the presence or absence of disproportion: the Hüllis impression method takes its place along with the methods of Kerr and Mueller and oftentimes is much more practical.

The volume is poorly illustrated, and this is especially true in the section devoted to gynecology.

A volume on obstetrics and gynecology for the practitioner should present the subject matter in the simplest form, perhaps outline, most of the space being devoted to diagnosis and treatment since these are the phases of the subject which concern the practitioner most. The book should be profusely illustrated, each step in a procedure being accurately described. The practitioner is not concerned with the historical side of a problem when he is confronted with a grave situation. He wants a quick, ready reference where the information may be gained in the shortest possible time and in the most concise and accurate form. It is impossible to carry out such an idea without clear illustrations.

CHRISTINA C. DOWNEY.

THIS Neuroanatomy by Globus is primarily "a guide for the study of the form and internal structure of the brain and spinal cord," and contains 53 plates of rough and incomplete outline figures of dissections and sections through the brain.

THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY. VOL. VI.—GYNECOLOGY AND OBSTETRICS. New York and London: D. Appleton-Century Company, 1934.

NEUROANATOMY. OFFICE FOR THE STUDY OF THE FORM AND INTERNAL STRUCTURE OF THE BRAIN AND SPINAL CORD. By J. Globus, M.D. 6th ed., 1934, 2nd ed. Baltimore: Williams, Wood and Co., 1934.

These outlines supply the student with uniform foundations for careful laboratory exercises, he is expected to complete the drawings and label them in the course of study.

A brief text including daily assignments occupies 122 pages of the book. This is developed especially for the author's course and can scarcely be expected to fulfill the requirements of every course in neuroanatomy. Arrangement is orderly and neat but illustrations are fewer than could be desired (36) and, unfortunately, are without labels. In the matter of study assignments, some instructors will unquestionably feel that class morale is being dealt staggering blows by expecting students to "write a concise summary of accepted views and facts regarding the general plan which forms the ground work for the structural organization of the central nervous system and to discuss briefly the contributions to neuroanatomy made by Nissl, Weigert, Golgi, Cajal, Harrison and Hortege" on the first laboratory period. It is the reviewer's opinion that it is doubtful whether a very large percentage of a normal class can do such assignments justice at the completion of the course. WILLIAM F. WIDMAYR.

ADDED material and revision bring up to date Beckman's deservedly popular book *Treatment in General Practice*.¹ The author has succeeded in the difficult task of presenting in one volume the treatment of the principal diseases of man exclusive of the legitimate specialties. He has quoted the principal writers on the individual subjects included, and has added his own, frequently pungent comments based on personal experience. A well selected bibliography is helpful to those who wish to study the original articles quoted. Discussion of treatment is prefaced by a description and historical survey of the disease.

In a work of this scope and character differences of opinion as to the value of certain agents in certain conditions are inevitable, but such criticisms are minor. In the opinion of the reviewer, for example, the praise of cinchobiphen as a valuable addition to our armamentarium, although it is followed by a warning as to possible dangers arising from its use were better replaced by a flat recommendation against its use. The author does not attempt however to outline the management of an individual case. Instead, he describes methods, quotes results enumerates and often evaluates the therapeutic agents available so that an intelligent selection of a method of procedure is possible. The chief value of the work is the presentation in one volume of the principles and methods of treatment believed to be the best available at the present time in the management of a great variety of diseases. The book should continue to serve as a valuable reference and guide to the general practitioner.

WALTER H. NADLER.

TREATMENT IN GENERAL PRACTICE. By Harry Beckman, M.D. 2d ed., 1934, 1st ed. Philadelphia and London: W. B. Saunders Company, 1934.

IN reading the preface to *The Origin of Cancer* by Lockhart Mummery¹ one is struck by the statement "This quest has at last been successful and the origin of cancer is now understandable." Coming from a man for whom the profession has such a high regard this statement incites, to say the least, an intense desire to learn what the theory is.

The author discusses the facts about tumors, old theories about the causes of tumors, normal and abnormal growth, the influence of heredity the genetic theory of inheritance somatic cell mutations malignancy frequency of mutation and again tumors, and from carefully selected evidence, he propounds a theory well stated in the preface.

The vast number of different varieties and species of living organisms that exist in the world today have been produced by chance changes or mutations in the nuclei of germ cells, sorted out and preserved by the aid of natural selection. We know that such genetic changes in cells are passed on to all succeeding descendants of the cells in which they occur, and if the change is one which is compatible with survival of the organism will result in a variation in one direction or another perhaps for something better perhaps for something worse. It is by such means that we ourselves have been evolved from more primitive organisms.

The important variations in organisms which have acted as the raw material for evolution have resulted from genetic mutations in germ cells. Tumors and cancer are variations from the normal similarly produced by mutations occurring in the nuclei of somatic or body cells.

Heredity takes two forms, that of the parent and the child (the organism as a whole) and that of the cells themselves which make up the organism. The child develops according to the cells it has inherited from its parents and the adult tissues develop according to the cells inherited from the original embryo. Any genetic change in the cell nuclei will be permanent during the life of the organism and if the change be one which involves an increased rate of growth, a tumor or cancer may result. In fact cancer is the result of a genetic change in a normal growing somatic cell.

The author states that a number of substances are known to result in gene mutations when applied to experimental animals dibenzanthracene being the most powerful. Tar will do likewise. Such agents as X ray and the rays of radium have a special capacity for producing mutations of genes or transmutation of chromosomes. In the human the cause is still in question however the appearance of cancer in homologous twins creates a suspicion.

The theory is open to much doubt and criticism yet any one who is interested in malignant disease will derive great interest and food for much thought while reading this little volume.

JOHN A. WOLFEN

THE ORIGIN OF CANCER. By J. P. Lockhart Mummery, M.A. M.B. B.C. (Cambridge) F.R.C.S. (Eng.) London: J. & A. Churchill, 1934.

THE 454 page monograph² by Martel and Gull-Isaume, based on the authors 139 cases of posterior fossa tumors which were operated on in their clinic between January 1930 and January, 1933, has been divided into 4 parts.

The first part describes the general symptoms from a physiological and anatomical standpoint. This again is subdivided into 4 chapters, the first of which describes the symptoms produced by increased intracranial pressure namely headaches, vomiting, papilloedema and hydrocephalus. Chapter 2 consists of a discussion of the body attitude disturbances of body tonicity changes in equilibrium, and co-ordination and vestibular disturbances under the general heading of the cerebellar vestibular syndrome. The involvement of the cranial nerves is taken up in the third chapter and motor sensory, and reflex disturbances are included in chapter 4.

In part II the tumors found in the posterior fossa are considered from a histological anatomical classification, whereas in part III they are classified according to the localization in the posterior fossa. A chapter each has been devoted to a general and rather complete discussion of first, tumors of the midline second tumors of the cerebellar hemispheres third, tumors of the cerebellar pontine angle fourth, tumors of the peduncles fifth, arachnoiditis of the posterior fossa and sixth studies of lesions simulating a neoplasm in the posterior fossa.

Surgical treatment as advocated by De Martel covers some 73 pages, and many illustrations are included. In contrast to the suboccipital craniotomy performed by most American neurosurgeons De Martel and his associates prefer the suboccipital osteoplastic flap. This type of operation and also De Martel's operative position are described in detail in this chapter.

Many cases are described in detail to illustrate the various types and locations of posterior fossa tumors. The bibliography is comprehensive especially of the French literature. The simplicity of the language and the clearness of the authors writing style allows for easy reading even for one who does not have an extensive knowledge of French. The monograph is a worth while addition to any medical library.

DAVID A. CLEVELAND

THE names of the eminent writers of *Lehrbuch der operativen Gynäkologie*³ are sufficient guarantee that it is a book well worth reading. The first edition of the book was originally written by Winter with the assistance of Benthin and Naujoks and was essentially an elaboration of his contribution to the Halban-Seitz *Biologie und Pathologie des Weibes*. The advice given is based not only upon

LES TUMEURS DE LA LOUPE CÉRÉBELLÉUSE, FOSSÉ CÉRÉBELLÉUSE POSTÉRIEURE, DIAPHRAGME ET CANTHÉTÉRIE. By Th. De Martel and J. Gull-Isaume. Paris: G. Doin et Co. 1934.

LEHRBUCH DER OPERATIVEN GYNEKOLOGIE. ACHTE VERBESSERTE AUFLAGE. By Prof. Dr. Georg Winter and Prof. Dr. Joseph Halban in collaboration with Prof. Dr. W. Benthin and Prof. Dr. A. Naujoks. 8th ed. rev. ed. Berlin and Vienna: Urban und Schwarzenberg, 1934.

the vast experience of the authors but also upon the results of other authorities. The indications and technique of every obstetric operation are given in minute detail. Furthermore, every type of injury to mother and child which may result from these operations is thoroughly discussed from the point of view of prevention, actual occurrence, and treatment. The section on forceps operations is particularly thorough and various types of instruments are described, including the Kielland forceps.

The different types of cesarean section are described and illustrated but the authors prefer the intraperitoneal or transperitoneal type. In the discussion on internal podalic version Winter properly warns that this intervention should not be practiced until the cervix is completely effaced and dilated so that immediate extraction may be performed. He proves the dire effects which occur for both mother and baby in the cases in which extrac-

tion is forced through an incompletely dilated cervix or in which the extraction is delayed because the cervix is not sufficiently dilated to permit delivery.

The book which is intended for general practitioners is written in simple, lucid language. The illustrations are abundant, clear and instructive. Many of them unfortunately show operations being performed with ungloved hands. The illustrations showing Schultze's swingings for the resuscitation of asphyxiated newborn babies should have been omitted because these swingings are dangerous. A number of illustrations are colored and others are arranged on large plates in such a way that each plate depicts all the stages of an obstetric operation. Even for those who cannot read German the book will prove instructive because the illustrations are self-explanatory. The book should prove helpful not only to general practitioners but also to obstetric specialists.

J. P. GREENHILL

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE ANEMIAS. By Janet M. Vaughan, D.M. (Oxon), M.R.C.P. (Lond.) With notes on normal and pathological erythropoiesis by Hubert M. Turnbull, D.M. (Oxon) F.R.C.P. (Lond.) London: Oxford University Press, 1934.

X RAY AND RADICUM IMPLANTS: THEIR FUNCTION AND TREATMENT. By Hector A. Colwell, M.B. Ph.D. M.R.C.P. D.P.H. and Selwyn Rime, C.B.E. D.Sc. F.Inst.P. London: Oxford University Press, 1934.

THE MEDICAL AND ORTHOPEDIC MANAGEMENT OF GONORRHOEA. By Ralph Pemberton, M.S., M.D. F.A.C.P. and Robert B. Osmond, A.B. M.D. F.A.C.S. New York: The Macmillan Company, 1934.

DIE PERINATOLOGISCHE FRUCHTBARKEIT UND UNFRUCHTBARKEIT DER WEIBER: DER WEG ZUR NATÜRLICHEN GEBURTSHILFE. By Professor Dr. Hermann Knäuper, Vienna: Wilhelm Maudsch, 1934.

COLLECTED PAPERS OF THE MIA O CLINIC AND THE MIA FOUNDATION. Edited by Mrs. Maud H. Mellish-Wilson, and Richard M. Hewitt, B.A., M.A. M.D. Volume XIV, 1933, published May 1934. Philadelphia and London: W. B. Saunders Company, 1934.

THE MERIC MANUAL OF THERAPEUTICS AND MATERIA MEDICA: A SOURCE OF READY REFERENCE FOR THE PHYSICIAN. 6th ed. Rahway N. J. Merck & Co. Inc. 1934.

I NUTRIZIONE DEL QUADRO DEI TUMORI GASTRICI. By Signor Dr. Mario Rocchini, Bologna, Italy. L. Cappelli, 1934.

STUDIES ON KNOCHENIMPLANTATION UND KNOCHEN-IMPLANTATION IMPLANTATION VON OS PECTUS BOVIS TRANSPLANTATION VON OS NOVIUM. By Svanne Orrell. Supplement 1934, Vol. 10. Acta Chirurgica Scandinavica: Göteborg, 1934.

ANIMALS OF ROENTGENOLOGY. A SERIES OF MONOGRAPHIC ATLAS. Edited by James T. Case, M.D. Vol. 1. POSITION BODY IN AIR AND FOOD PASSAGES. By Chevalier Jackson, M.D., and Chevalier L. Jackson, M.D. New York: Paul B. Hoeber, Inc., 1934.

APPLIED PHYSIOLOGY. By Samson Wright, M.D. F.R.C.P. 5th ed. New York and London: Oxford University Press, 1934.

NEURALGIA AND ALLIED DISEASES, THEIR PATHOLOGY AND TREATMENT. By Robert Platt, M.D. (Sheff.) M.R.C.P. (Lond.) London: Oxford University Press, 1934.

PORTER LECTURES. SERIES III. BLEEDING AND CANCEROUS GASTRIC DISTURBANCES. By J. Shelton Hensley, M.D. Lawrence, Kansas: University Extension Division, University of Kansas, 1934.

MANUAL OF THE DISEASES OF THE EYE, FOR STUDENTS AND GENERAL PRACTITIONERS. By Charles H. May, M.D. 14th rev. ed. Baltimore: William Wood and Company, 1934.

CLINICAL MISCELLANY. THE MARY LUCY BARNETT HOSPITAL, COOPERSTOWN, NEW YORK. By various authors. Volume I. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1934.

THE HEART OF YOUNG. By S. Calvin Smith, M.D. Sc.D. Philadelphia, London, and Montreal: J. B. Lippincott Company, 1934.

CORRESPONDENCE

REPORT OF COMMITTEE OF NEW YORK OBSTETRICAL SOCIETY, ON MATERNAL MORTALITY

To the Editor In November 1933 the Commonwealth Fund of New York published a book entitled *Maternal Mortality in New York City: A Study of All Puerperal Deaths 1930-1932*, by the Committee on Public Health Relations of the New York Academy of Medicine.

On November 30 1933 the Medical Information Bureau of the Academy of Medicine released to the daily newspapers an abstract of this book under the title *Why Women Die in Childbirth*. Although very properly presenting many of the outstanding facts in this excellent study the newspaper articles created certain impressions that were unnecessarily alarming and misleading. With a desire to correct these unfortunate impressions concerning the Maternal Mortality Report, to clarify certain points at issue, and to secure constructive suggestions for the improvement of existing conditions, the New York Obstetrical Society on March 13, 1934 appointed a committee to take the entire subject under consideration and make recommendations.

The report of this committee herewith presented was read and endorsed by the New York Obstetrical Society at a regular meeting on April 10 1934. The committee was asked to continue and instructed to formulate plans to carry out the recommendations of its report.

EDWARD A. BUTLAND, M.D.

President, New York Obstetrical Society

Mr. President and Members of the Society Your committee desires to make its report, signed by all its members. We have felt it desirable to report on the following topics:

I. PREVENTABILITY

a. Your committee feels that it is impossible in all cases to determine preventability and agrees entirely in this respect with the report when it says, "It was realized that, with our present knowledge, it was impossible to arrive at a scientifically correct determination of preventability. Furthermore the committee feels that the report has gone too far in placing this responsibility."

b. Instead of judging a death as preventable it seems far wiser to your committee to judge such a death as associated with a controllable cause.

c. Your committee feels that in the release to the newspapers it should have been stated the high maternal death rate in New York City is due largely to controllable causes—instead of stating as it did

that, "responsibility for the occurrence of the 1,343 deaths which the committee adjudged preventable was distributed amongst physicians, patients, and midwives. To the medical group is charged 61.1 per cent of the preventable deaths, to the patient 36.7 per cent of the deaths, and to the midwives 2.2 per cent of the total of these deaths."

d. Your committee feels that the conclusions in the report, as well as those released to the lay press regarding preventability and responsibility may result in unfair criticisms or even unjust law suits for malpractice.

e. Your committee feels that in this vicinity the New York Obstetrical Society is the most authoritative body in any matter pertaining to childbirth and as such this society should go on record not only in its own archives but also in the lay press, as to its opinion on all controversial statements—e.g., operative deliveries, such as forceps, version, cesarean sections, also anesthesia, analgesia, home and hospital deliveries, and the complications of pregnancy, labor and the puerperium.

II. MIDWIVES

a. Your committee believes that the report released by the Academy to the public distorted the facts as to preventability of midwife deaths.

b. Your committee believes that any accurate release to newspapers on preventability should give the percentage of preventable mortality for the physician group and for the midwife group, which according to the report is 68 per cent for the former and 75 per cent for the latter.

c. Your committee believes that while there is need for better training and supervision of the present licensed midwives, there is no need for training or licensing of additional midwives. The records show that during the past 20 years in the City of New York there has been a steady decline in the practice of midwives—from 50 per cent to 8.3 per cent at the present time. In order to accomplish the better training and supervision of the existing midwives, we recommend that the New York Obstetrical Society offers its services to the commissioner of health of the City of New York.

d. Your committee believes that the practice of obstetrics will never be elevated to the position it rightly deserves as long as the midwife is permitted to practice. The profession, as well as the majority of the laity, is perfectly cognizant of the limitations of the midwife, and the teachers and leaders of obstetrics should, by now appreciate the inadequacy of any system which introduces incompetency in competition with scientific knowledge.

III. HOSPITAL AND HOME DELIVERIES

a. Your committee believes that the report does not differentiate hospitals along lines of efficiency and equipment as laid down by the American College of Surgeons and the American Medical Association. The American College of Surgeons has published minimum standards for hospitals taking obstetric patients and we feel that these standards should have been utilized in classifying the hospitals of New York City. If this scheme had been followed, the final conclusions as published by the report, regarding hospital deliveries, would have been more in keeping with the facts and it would inevitably have recommended hospital delivery in preference to home delivery except in so far as the inadequate hospital is concerned. Furthermore we recommend that this latter type of hospital be placed under the supervision of a regional committee, in co-operation with the Department of Hospitals.

b. Your committee recommends that the New York Obstetrical Society should approve home deliveries only under ideal conditions as to competent medical attendance or supervision, equipment and assistance.

IV. OPERATIONS

Your committee feels that the report did not emphasize the fact that many operations were undertaken without sufficient indications in unskilled hands. We all know that operative deliveries, with good indications in skilled hands, are necessary. They are merciful and life-saving and they constitute one of the great advances of modern obstetrics.

V. ANESTHESIA AND ANALGESIA

Your committee believes that the use of anesthetics and analgesics when properly selected and properly administered, are valuable and indispensable and should be encouraged. They are not only humane but tend to prevent unnecessary and too early interference with the natural progress of labor and *per se* do not add to the maternal or fetal death rate, or to operative interference.

VI. EDUCATION

Your committee is unanimously of the opinion that the New York Obstetrical Society should go on record in the medical and lay press as to its attitude regarding education and training in obstetrics and gynecology. This seems necessary in order that the society may use its full influence in an endeavor to accomplish the following:

a. The medical schools in New York City should allow as much time for the undergraduate teaching of obstetrics as is allotted to surgery or medicine. The committee is of the opinion that one of the strongest factors in reducing maternal mortality is better teaching of obstetrics in our medical schools. Obstetrics and gynecology must be placed on a par with medicine and surgery in every first class medical school in this country.

b. Hospital training in obstetrics for those who plan to practice obstetrics must be adequate. An

obstetrical internship should not be less than one year and a general rotating internship in which obstetrics is included, should be at least two years, in order to allow a minimum of six months for obstetrics.

c. All university and other qualified hospitals should utilize their facilities, wherever possible to offer postgraduate courses in obstetrics and gynecology.

d. Only through these three factors, adequate undergraduate teaching, thorough hospital training and postgraduate courses, will the obstetrical standards of the work in all our hospitals be elevated to the required level of efficiency and safety.

e. Furthermore the lay public, through the various public health agencies, including the Department of Health, should be informed of the requirements of a physician doing obstetrics: the standards of hospitals taking obstetric cases and finally what the patient herself should know about pregnancy, labor and the puerperium.

VII. PUBLICITY IN THE LAY PRESS

Your committee recommends that the following be an official release made at this time from the New York Obstetrical Society to the lay press:

The New York Obstetrical Society after careful study and discussion of the *Report on Maternal Mortality in New York City* by the Public Health Relations Committee of The New York Academy of Medicine, releases the following official statement to the lay press:

"This society believes that the valuable and excellent report of the committee has, in its publication in the lay press, been misrepresented. It believes that because of this publication, the laity and many of the medical profession have gained false impressions concerning childbirth and maternal mortality in this city. A careful scrutiny and analysis of the report itself will correct these false impressions. Such scrutiny and analysis, however for obvious reasons, will not be made except by a comparatively few doctors especially interested.

This society believes, therefore that it is necessary to issue this statement, in the lay press, both to correct false impressions previously created, and to give its authoritative opinion on controversial subjects connected with childbirth in New York.

The statement was made in the lay press that of the 3,041 maternal deaths occurring in the three years of study 65.8 per cent were preventable, and of these 1,343 preventable deaths, the predominant responsibility was charged to the medical group in 61.5 per cent of the cases, to the patients themselves in 36.7 per cent of the cases, and to the midwives, who handled only a small number of cases of the uncomplicated type, in 1.8 per cent of the fatalities. This society believes that the facts do not warrant this statement. According to the report responsibility is ascribed to the physician in 67.8 maternal deaths, which is 47 per cent of the deaths occurring among patients attended by the physician

while the midwife was responsible for 29 maternal deaths or 60.4 per cent of the deaths in women attended by the midwife. This is the only fair way to regard the deaths in the physician and midwife groups, because when expressed as a percentage of all deaths the midwife figure is materially reduced due to the fact that she attended only 8.47 per cent and the doctor 91.5 per cent of all confinements. Furthermore, it must be pointed out that it is almost impossible to ascribe responsibility in a large percentage of cases, contrary to the conclusions of the Report.

Many of the maternal deaths were undoubtedly associated with controllable causes. Some of these causes, however, existed long before the patient was seen by the attendant and even before pregnancy. Elimination of these causes would presuppose adequate medical care from infancy, and that many of these patients did not have. With regard to preventability however this society feels that it is often impossible to determine preventability and agrees entirely with the report itself when it says, "It was realized that, with our present knowledge, it was impossible to arrive at a scientifically correct determination of preventability. How then could it be possible to publish in the lay press the exact percentages of responsibility in the case of the doctor the patient and the midwife?"

This society feels that the press report has given the impression, unmistakably, that all of the 2,041 maternal deaths, in the three years of study occurred in actual childbirth from puerperal causes. The report shows clearly, however, that 40 per cent of these deaths occurred in early pregnancy and from non-puerperal causes 477 being due to abortions and ectopic gestations and 344 to extra puerperal causes and consequently only 1,220 of the 2,041 deaths listed occurred in actual childbirth from puerperal causes. This gives a maternal mortality rate in actual childbirth from puerperal causes of 3.5 per 1,000. The figure 5.9 per 1,000 published in the lay press was the total death rate from all causes whatsoever occurring in pregnant women. The society believes that the public should understand the meaning of these two sets of figures.

The published report in the press stresses the fact that operative deliveries carry a maternal mortality five times as high as do spontaneous deliveries and states that, any such disparity as that shown in these figures is a certain indictment of those undertaking the interference. This society feels that such indictment is grossly misleading. What the committee had in mind, in giving out this statement, was that operative deliveries without good indication, in unskilled hands tend to increase maternal mortality. The committee knows, as all obstetricians know that operative deliveries at times are absolutely necessary for the safety of the mother or baby and that, with good indications, in skilled hands, they are merciful life-saving, and constitute one of the greatest advances of modern obstetrics. Under such conditions, operative deliveries do not increase

maternal mortality but on the contrary, lower it, together with fetal mortality.

"The press report states that caesarean section is rapidly on the increase and further says, while a 2 per cent of all deliveries were made by caesarean section, this operation was responsible for almost one fifth of all the deaths. This society believes that this statement is most misleading unless carefully explained. The society deplors the performance of this operation as done too frequently with insufficient indication by the unfit. But the fact remains that the operation is absolutely essential to life of mother and baby in many instances due to the physical structure of the mother or for other causes. Many obstetricians in this city can show a large series of caesarean sections with very low maternal mortality or even with no mortality whatever. Done skillfully at the proper time, caesarean section carries a comparatively slight risk to the mother and practically none to the baby. Any one caring to read the records of obstetric deliveries before the accepted use of caesarean section, will be shocked at the horror of some of the agonizing long-drawn-out labors, ending in disaster to both mother and baby. Caesarean section is one of the greatest blessings to womanhood. It is its abuse only that must be deplored.

The press reports states that 1.9 per 1,000 of the 1,343 preventable deaths occurred in the home while 4.5 per 1,000 occurred in hospitals. It says further it would seem that the present attitude toward home confinement requires re-examination and a program looking toward an increase in domiciliary obstetrics, deserves careful investigation. This society is of the opinion that delivery in a well organized and well equipped hospital is safer than home delivery. This society believes that obstetrics is no longer a one man job and that home deliveries should not be encouraged, unless they can be conducted with every safeguard of medical supervision, equipment, and assistance. This it is well known, is rarely the case. Moreover the society believes that the lower mortality in home compared with hospital deliveries, as found in the report is easily accounted for by the fact that usually only the short and normal labors are conducted at home, while the protracted and difficult ones are transferred to hospitals, with the patients often in desperate or dying condition. Deaths of such patients swell the hospital records but they should properly be listed as fatalities from home deliveries. If they were home deliveries would be found to carry a higher mortality than those in hospitals. This is what might be expected.

The press report as given out by the committee expresses the belief that the use of anesthesia among other causes stated is responsible for the increase in operative deliveries. This society thinks that this belief is ill founded, and on the contrary is of the opinion that anesthesia and analgesia (partial anesthesia), properly selected and skillfully administered, are essential and valuable and should be

encouraged, not only as humane, but also as tending to prevent unnecessary and too early interference with the natural progress of labor and that they do not increase operative delivery. Furthermore, this society is convinced that anesthesia and analgesia, in the hands of well trained doctors, do not add to the maternal or fetal death rate.

This society wishes to call attention to the fact that the specialty of obstetrics is not an exact science, that some women may die in childbirth after normal confinements and where no one is to blame, patient, doctor or hospital. It is the aim of good obstetrics to lower the maternal mortality to an irreducible minimum, as demonstrated by the better hospitals in our own and other communities. This society believes that it is well for the public to consider these facts before resorting to hasty criticism.

"This society is of the opinion that improvement in obstetric conditions cannot be expected from dependence on the midwife. Midwives are decreasing in numbers. In this city twenty years ago approximately five times as many women were delivered by them as today. They are frequently a menace to the health of the women under their supervision. This society believes that the care of the expectant mother is too important and too technical to be intrusted to attendants without complete and adequate medical training and it also believes that all parturient women in the city before long can be cared for by the medical profession.

This society is, therefore, of the opinion that, for the present the midwives now licensed in the City of Greater New York should be properly supervised and examined, and it is ready to co-operate with the Department of Health and other organizations in this matter. It, however is opposed to the training of additional midwives.

This society is of the opinion that the maternal mortality can be materially reduced by allowing more time for the teaching of obstetrics in our medical schools, by placing more emphasis on such undergraduate teaching, by concerted postgraduate and hospital training for those doctors who will practice obstetrics either exclusively or otherwise, and lastly by providing adequate hospital facilities for maternity patients, which should include as advised by the American College of Surgeons:

- a. Segregation of obstetric patients from all others in the institution.
- b. Special facilities available for immediate segregation and isolation of all cases of infection, fever or other conditions inimical to the safety and welfare of patients within the department.
- c. Adequately trained personnel, the entire nursing staff to be chosen specially for work in this department and not permitted to attend other cases during this time on obstetric service.
- d. Readily available, adequate laboratory and special treatment facilities under competent supervision.

e. Accurate and complete clinical records on all obstetric patients.

f. Frequent consultations encouraged on obstetric service, a consultation made obligatory in all cases in which major operative procedure may be indicated.

g. Thorough analysis and review of the clinical work of the department each month by the medical staff with particular considerations to deaths, infections, complications, or such conditions as are not conducive to the best end-results.

h. Adequate theoretical instruction and practical experience for student nurses in prenatal, parturient, and postpartum care of the patient as well as the care of the newborn.

"This society is of the opinion that the general public should know that it is necessary for all women to have adequate medical supervision and care during pregnancy, labor and the postpartum period, such supervision and care to begin early in pregnancy and to be continuous throughout the postpartum period.

a. In order to safeguard the health of both mother and child.

b. In order especially to control the infections, toxemias, and hemorrhages that this study and others have shown to be real menaces to life.

c. In order to minimize the danger of death or serious invalidism following abortions, spontaneous or induced.

VIII CO-OPERATION WITH MEDICAL ORGANIZATIONS AND PUBLICITY TO THE MEDICAL PROFESSION

Your committee recommends that the New York Obstetrical Society appoint a committee to co-operate with the Department of Health, the Department of Hospitals, and other agencies, in order to accomplish the above recommendations regarding midwife practice, undergraduate and postgraduate education, regulation or registration of physicians practicing obstetrics, supervision of all hospitals doing obstetrics which do not conform to the minimum standards of the American College of Surgeons and to evolve a plan for a Board of Regional Consultants in Obstetrics and Gynecology. We further recommend that, with respect to our report, such a committee be empowered to consider and act in the matter of publicity to the medical profession, as well as to the lay public.

IX FETAL MORTALITY

Your committee recommends that in any further study of maternal mortality fetal mortality should be included as giving a more complete and accurate analysis of our results in childbirth.

ELIOT BIRKOP, Chairman
HARVEY B. MATTHEWS, Secy
GEORGE H. RYDER
HENRIKUS J. STAMPER
EDWIN G. LANGRISH

Committee

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

WILLIAM D. HAGGARD Nashville, *President*

ROBERT B. GREENOUGH Boston *President Elect*

FRANKLIN H. MARTIN Chicago *Director-General*

ARTHUR W. ALLEN *Chairman* ERNEST M. DALAND, *Secretary Committee on Arrangements*

PLANS FOR THE 24TH ANNUAL CLINICAL CONGRESS IN BOSTON

PLANs for the twenty fourth annual Clinical Congress of the American College of Surgeons to be held in Boston October 15-19 1934, are approaching completion. The surgeons of that great medical center have organized under the leadership of a strong and representative committee planning to provide for the Fellows of the College and their guests a program of surgical clinics and demonstrations that will present a most complete showing of their clinical activities in all departments of surgery. The Committee on Arrangements has been assured of the hearty co-operation of the clinicians at the medical schools and more than thirty hospitals that will participate in the clinical program.

There is published in the following pages a preliminary program of clinics and demonstrations as prepared by the Committee on Arrangements. It should be noted that operative clinics and demonstrations in the hospitals are scheduled for the afternoon of Monday, October 15 beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days. The schedules appearing herewith are to be revised and amplified as the work of the program committee progresses during the intervening months. The final program will be published from day to day during the Congress—a complete and accurately detailed program being posted in the form of bulletins at headquarters each afternoon for the succeeding day and issued in printed form the following morning.

The Committee plans to include in the clinical program many special features, among them being (1) Fracture clinics at which modern methods in the treatment of fractures will be demonstrated (2) cancer clinics demonstrating the treatment of cancer by surgery, radium, and (3) clinics in traumatic surgery for the pres-

entation of methods of rehabilitation of injured patients by surgery and physiotherapy.

CANCER SYMPOSIUM

On Wednesday afternoon in the ballroom of the Copley Plaza Hotel a symposium on cancer will be presented under the auspices of the College Committee on the Treatment of Malignant Diseases. This will include further reports by clinicians from various parts of the United States and Canada presenting additional statistics on the cure of cancer in addition to reports presented at the 1932 and 1933 sessions of the Clinical Congress.

CHARLES A. DUTCH, Oakland Calif., Presiding
General Subject of Curability of Cancer FRANKLIN H. MARTIN Director-General.
General Cases of Five Year Cures. ROBERT S. LATHCART, Charleston S. C. ROY D. McCURE and ARTHUR McGRAW, Detroit, MONT. R. REED and WILLIAM MILLAR, Cincinnati. FRANCIS CARTER WOOD and BENJAMIN RICE, SNOW, New York.
Cancer of the Pelvic Organs and Breast. FREDERICK C. HOLDEN, New York. C. JEFF MILLER, New Orleans.
Cancer of the Breast. HUBERT A. ROYSTER, Raleigh N. C. HUGH H. TROUT, Roanoke, Va.
Cancer of the Pelvic Organs. FREDERICK J. TAUBS, St. Louis.
Cancer of the Genito-Urinary Organs. EDWIN BEER, New York.
Cancer of the Mouth and Larynx. GORDON B. NEW, Rochester, Minn.
Lymphatic Tumors. LLOYD F. CRAVER, New York.

Following these reports a group of papers descriptive of accepted methods for the treatment of cancer will be presented as follows:

Cancer of the Stomach Treated by Surgery. J. SHELTON HORSLEY, Richmond, Va.
Cancer of the Cervix Treated by Surgery and Irradiation. GEORGE GRAY WARD, New York.
Cancer of the Breast Treated by Surgery and Irradiation. STUART W. HARRINGTON, Rochester, Minn.

Cancer of the Lip Treated by Surgery and Irradiation
 ELLIS FRICHEL, St. Louis
 Cancer of the Bladder Treated by Surgery and Irradiation
 WILLIAM E. LOWER, Cleveland.

FRacture CONFERENCE

A conference on fractures, under the auspices of the College Committee on the Treatment of Fractures, will be held in the ballroom of the Copley Plaza Hotel on Tuesday afternoon.

Among the papers to be presented are the following:

One Thousand Consecutive Fractures of Both Bones of the Leg WILLIAM SIMON in collaboration with J. SMITH NORMAN, Pueblo, Colo.
 Treatment of Fracture of the Carpal Scaphoid D. W. GORDON MURRAY, Toronto.
 Fractures of the Jaw ROBERT H. IVY, Philadelphia.
 Acute Fractures MELVIN S. HENRIKSON, Rochester, Minn.

Also, under the auspices of the same committee, demonstrations of approved methods of treating fractures will be conducted daily as a part of the scientific exhibition in the Statler Hotel ballroom.

OTHER FEATURES OF THE PROGRAM

A conference under the auspices of the Board on Industrial Medicine and Traumatic Surgery is planned for Friday afternoon in the ballroom of the Copley Plaza Hotel. The College is continuing its investigations and surveys in the industrial areas to ascertain the facts as to present medical conditions in industry and to inform employers of adequate methods of organization and administration. A further report on such surveys will be made at this conference.

Surgical motion picture films, both sound and silent, will be exhibited daily in the Georgian Room at the Statler Hotel. Many new films will be shown. The showing of films demonstrating clinical features of interest has met with popular acceptance in recent years and will be continued at this session with an enlarged program.

Ether Day will be celebrated at the Massachusetts General Hospital on Tuesday with special exercises at 4 p. m. in the dome room of the old building of the hospital where ether was first administered for the production of surgical anesthesia on October 16, 1846.

EVENING MEETINGS

Programs for five evening sessions, as prepared by the Central Executive Committee, will be found in the following pages. At the presidential meeting on Monday evening in Symphony Hall, the president-elect, Dr. Robert B. Greenough, of

Boston, will deliver his inaugural address. On that occasion a number of distinguished surgeons from abroad who will be in attendance at the Clinical Congress will be introduced. Among the visiting surgeons will be the following: Prof. John Frazer, Edinburgh, Scotland; Dr. Bethel Solomons, Dublin, Ireland; Sir Harold Gillies and Mr. A. Lawrence Abel, London, England; Mr. Harry Platt and Dr. William F. Shaw, Manchester, England; Dr. Alexander MacLennan, Glasgow, Scotland; Dr. Rafael Silva, Mexico City, Mexico; Prof. Josef Halban, Vienna, Austria. A feature of this session will be the John B. Murphy oration in surgery by Dr. Donald C. Balfour.

Sessions on Tuesday, Wednesday and Thursday evenings will be held in the ballroom of the Copley Plaza Hotel at which eminent surgeons of the United States and Canada, together with visiting surgeons from foreign countries, will present papers on surgical subjects of timely importance.

The annual Convocation of the College will be held on Friday evening in Symphony Hall at which the 1934 class of candidates will be received into Fellowship in the College.

OPHTHALMOLOGY AND OTOLARYNGOLOGY

The committee in charge of the section on surgery of the eye, ear, nose, and throat has arranged a program of ophthalmological and otolaryngological clinics and demonstrations at the hospitals and medical schools. This appears in the following pages, and in addition programs for sessions on Tuesday, Wednesday, Thursday and Friday afternoons in John Hancock Hall, located on St. James Avenue midway between the Statler and Copley Plaza Hotels. At these sessions distinguished specialists will present papers on subjects of timely interest.

A symposium on "Diseases of the Esophagus" will be presented on Thursday afternoon at 3:30 in the ballroom of the Copley Plaza Hotel following the annual meeting. The program follows:

An X-ray Study on Lesions of the Esophagus (statistical study with lantern slides) A. S. MACMILLAN
 Infection of the Esophagus in Acute and Chronic Disease
 Fibrosis of the Terminal Portion of the Esophagus (Cardiopharynx) Etiology and Treatment HARRIS P. MOSKOW
 The Surgical Approach to the Esophagus EDWARD D. CROSSLAND

HOSPITAL CONFERENCE

The annual Hospital Standardization Conference will open the Congress with a session in the ballroom of the Copley Plaza Hotel at 10 o'clock on Monday morning. An interesting program of papers, round table conferences, and practical

demonstrations is being prepared for sessions to be held on Monday, Tuesday Wednesday, and Thursday mornings at the Copley Plaza Hotel, with afternoon sessions at several of the hospitals. In this program will be presented two problems of major concern to all hospitals—sterilization of surgical dressings, instruments and supplies, and standards for maternal care in hospitals. Both subjects are attracting widespread interest, and various aspects will be presented by recognized authorities. In addition to the symposia ample opportunity will be afforded for round table discussions.

A greatly increased interest on the part of surgeons in both the administrative and scientific phases of hospital work has been evidenced in recent years and the program for this year's conference will be unique in providing for discussions of subjects of interest to the three major hospital groups—medical nursing and administrative. The College aims to make this year's program of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives, particular emphasis being directed toward professional standards and the vital problems related to medical economics.

HEADQUARTERS

The Statler and Copley Plaza Hotels will be utilized as headquarters for the Congress. At the former the grand ballroom and adjoining assembly room together with other large rooms on the mezzanine floor have been reserved for the exclusive use of the Congress for registration and clinic ticket bureaus, bulletin boards technical exhibition, and executive offices. A scientific exhibit, which will be arranged by the local committee is to be installed in the balcony of the ballroom. At the Copley Plaza Hotel the grand ballroom will be utilized for evening scientific meetings, hospital conferences and other large gatherings daily.

The technical exhibition will be located in the ballroom and adjoining assembly room at the Statler Hotel. The registration and clinic ticket desk, together with the information bureau will be located in these rooms in which will also be found the bulletin boards on which the daily clinical programs will be posted each afternoon. The leading manufacturers of surgical instruments, X ray apparatus, operating room lights, hospital apparatus and supplies of all kinds, ligatures dressings pharmaceuticals, and publishers of medical books will be represented in this exhibition.

ADVANCE REGISTRATION

The hospitals and medical schools of Boston afford accommodations for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore, that those surgeons who wish to attend the Clinical Congress in Boston will register in advance.

Admittance to all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card which is non-transferable must be presented in order to secure clinic tickets and admission to the evening meetings.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Boston session of the Clinical Congress so that the total fare for the round trip will be one and one-third the ordinary first-class one way fare. To take advantage of the reduced rates it is necessary to pay the full one way fare to Boston, procuring from the ticket agent when purchasing ticket, a "convention certificate," which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of the viséd certificate to the ticket agent in Boston not later than October 23 a ticket for the return journey by the same route as traveled to Boston may be purchased at one-third the one way fare.

In the eastern central, and southern states and eastern provinces of Canada tickets may be purchased between October 11 and 16, in other sections of the United States and Canada at earlier

Cancer of the Lip Treated by Surgery and Irradiation
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PRELIMINARY PROGRAM FOR EVENING MEETINGS

Presidential Meeting—Monday—October 15 8 15 p m

Address of Welcome ARTHUR W ALLEN, M D Boston, Chairman, Committee on Arrangements

Introduction of Foreign Guests FRANKLIN H MARTIN M D, Chicago Director General

Address of Retiring President WILLIAM D HAGGARD M D, Nashville Tenn.

Inauguration of Officers

Inaugural Address. ROBERT B GREENOUGH M D, Boston

John B. Murphy Oration in Surgery DONALD C. BALFOUR, M D Rochester Minn.

Tuesday—October 16 8 15 p m

Living Grafts of Thyroid and Parathyroid Glands HARVEY B STONE M.D., Baltimore with the collaboration of JAMES C OWINGS, M.D., and GEORGE O GUY M D., Baltimore

Endocrine Mechanisms in Certain Functional Gynecological Disorders. EMIL NOVAK M.D. Baltimore

Skeletal Lipoid Granulomatosis JOHN FRASER, M D Ch M F.R.C.S (Edin.) Edinburgh Scotland

Fracture Oration. KELLOGG SPEED, M D Chicago

Wednesday—October 17 8 15 p m

Hydrocephalus and Spina Bifida WILDER PENFIELD M D Montreal

Sterility with Special Reference to Surgical Possibilities BETHEL SOLOMONS M.D. F.R.C.P.I., Dublin, Ireland

Diverticulosis and Diverticulitis. IRVIN ABELL, M.D., Louisville

Thursday—October 18 8 15 p m

Symposium on Treatment of Infections

Infections of Clean Operative Wounds. FRANK L. MELENEY M D New York

Infections of the Lip and Face FREDERICK A. COLLIER, M D Ann Arbor Mich.

Phagedenic Ulcer Its Recognition and Treatment EMILE HOLMAN M D San Francisco

The Repair of Defects Resulting from Full Thickness Loss of Skin from Burns JAMES B BROWN M D St Louis

Convocation—Friday—October 19 8 15 p m

Invocation

Presentation of Candidates for Fellowship FRANKLIN H. MARTIN M D Chicago, Director General

Conferring of Fellowships. The President

Conferring of Honorary Fellowships. The President

Presidential Address ROBERT B GREENOUGH M.D. Boston

Fellowship Address

OPHTHALMOLOGY AND OTOLARYNGOLOGY—SCIENTIFIC SESSIONS

Tuesday—John Hancock Hall, 2—Ophthalmology

- JOHN M. WHEELER**, New York. Plastic ophthalmic surgery. Discussion opened by **W. B. LARGASTER**.
- JAMES S. FRIEDENWALD**, Baltimore. Slit lamp ophthalmoscopy. Discussion opened by **J. H. WATKIN**.
- CLARENCE KING**, Cincinnati. Tuberculin in the treatment of ocular tuberculosis. Discussion opened by **MERRELL KING**.
- RAFAEL SILVA**, Mexico City. Subject to be announced.

Wed. day—John Hancock Hall, 2—Otolaryngology

- THOMAS E. CARMODY**, Denver. Congenital deformities of the face and neck. Discussion opened by **A. H. KARAVYAN**.
- LOUIS H. CLIFF**, Philadelphia. Personal endoscopy in otolaryngological practice.
- SAMUEL J. CROWZ**, Baltimore. Ménière's symptom complex. Discussion opened by **PHILIP MELTZER**.
- JOHN R. PAGE**, New York. Acute infections of the middle ear and mastoid.
- O. JASON DIXON**, Kansas City. A departure in the management of acute mastoid disease or the advantages of conservative treatment in acute mastoid disease. Discussion opened by **LUDWIG RICHARDS**.
- GEORGE M. COOPER**, Philadelphia. Diagnosis of chronic infection of the tonsils in relation to indications for operation in cases of chronic focal infection.
- WILLIAM A. MURPHY**, Cleveland. Present status of infection of the upper respiratory tract in its relation to focal infection. Discussion opened by **H. JACKSON ALLEN**.
- EDWARD ZIEGLERMAN**, San Francisco. The clinical and surgical significance of the component cellular characteristics of the temporal bone based upon a series of 100 cadaver and autopsy observations, lantern slide demonstration.

Thursday—John Hancock Hall, 2—Ophthalmology

- LUTHER C. PETER**, Philadelphia. The technique of orthoptic training in strabismus. Discussion opened by **DAVID MILLS**.
- HARRY S. GRADLE**, Chicago. Recent therapeutic procedures. Discussion opened by **ALLAN GREENWOOD**.
- WILLIAM L. BISHOP**, Rochester, Minn. Subject to be announced. Discussion by **W. MILLBROOK LOWELL**.
- C. N. SPERRY**, Minneapolis. Closure of the cataract incision (motion pictures).

Ballroom, C. Play-Place Hotel—3:30—Otolaryngology

- A. S. MACMILLAN**. An X-ray Study on Lesions of the Esophagus (statistical study with lantern slides).
- HARRIS P. MOWERY**. Infection of the Esophagus in Acute and Chronic Disease, Fibrosis of the Terminal Portion (Lanthorn). Etiology and Treatment.
- EDWARD D. CHURCHILL**. The Surgical Approach to the Esophagus.

Friday—John Hancock Hall, 2—Otolaryngology

- SAMUEL J. KOPPELBY**, New York. Recent developments in the diagnosis of meningitis.
- WELLS P. EAGLETON**, Newark, N. J. Meningitis—result of disease of the petrous apex and sphenoidal base.
- MARVIN F. JOYCE**, New York. Pathways of approach to the petrous pyramid. Discussion by **HARRY P. CARTER**.
- WILLIAM MITCHELL**, Cincinnati. When and how shall a nasal sinus inflammation be treated nonoperatively?
- EDWARD C. SUTTELL**, San Francisco. Operative treatment of rhinitis, external approach. Discussion opened by **CHARLES T. PORTER**.
- CURTIS TUCKER**, Philadelphia. Cancer of the larynx.
- HENRY B. ORTON**, Newark, N. J. Cancer of the laryngopharynx. Discussion opened by **LEROY A. SCHALL**.

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, ORTHOPEDICS, UROLOGY,
PROCTOLOGY, SURGICAL PATHOLOGY, ETC

CHILDREN'S HOSPITAL

Monday

- W E LADD and associates—1. Fractures in children. W E LADD—9.30 Elbow fractures. T H LANZMAN—Fractures of the femur. P J MAHONEY—Fractures of both bones of the forearm.

Tuesday

- F R OBER and associates—9. Orthopedic operations.
W E LADD—9.30 Plastic repair of harelip and cleft palate, demonstration of cases, motion picture demonstration.
THOMAS H. LANZMAN—10. Acute osteomyelitis in infancy and childhood.
PATRICK J. MAHONEY—10.30 The use of various types of skin grafts in children's surgery.
HENRY HUDSON JR.—11. Acute appendicitis in childhood. Meckel's diverticulum.
Staff—1. Operative clinic, surgery in infants and children.
Staff—2. Orthopedic clinic. A T LEOO—Early treatment and the prevention of deformities in poliomyelitis.
F R OBER—Shoulder operations. J W SEVER—Stabilization of the ankle joint. M KATZ—Tendon transplants. A T LEOO—Abductor lump.

Wednesday

- F R OBER and associates—9. Orthopedic clinic at Pea body Home.
Staff—9.30 Operative clinic.
W E LADD—1. Congenital hypertrophic pyloric stenosis. Intussusception, diagnosis and treatment.
DONALD W. MACCOLLUM—1.30 Treatment of undescended testes, end-results over a 24 year period.
THOMAS H. LANZMAN—3. Chronic pulmonary suppuration, demonstration of cases.
HENRY HUDSON JR.—3.15 Empyema in childhood its treatment.
STURGEY PARKER—3.30 Surgical pathology of malignant tumors in infancy and childhood, followed by demonstration of pathological specimens in department of pathology.
EDWARD C. VOOR—3.45 Roentgenological studies of unusual bone tumors in infancy and childhood.

Thursday

- F R OBER and associates—9. Orthopedic operations.
W E LADD—9.30 Intestinal atresia, diagnosis and treatment, demonstration of cases, lantern slides.
PATRICK J. MAHONEY—10. Types of tracheo-esophageal fistulae: differential diagnosis and operative treatment. Congenital and acquired esophageal stricture: demonstration of methods of dilatation.
W E LADD—10.30 Atresia of the bile ducts, diagnosis and treatment, choledochus cyst: diagnosis and treatment.
THOMAS H. LANZMAN—11. Ureteral transplantation for exstrophy of the bladder: demonstration of treated cases.
Staff—2. Operative clinic, surgery in infants and children.
Staff—3. Orthopedic dry clinic. A H. BREWSTER—Claw feet. F H. MORRIS—Torticollis, mastoid approach.
H. FITZSIMMONS—Discussion. F R OBER—Semi-lunar cartilage. H. FITZSIMMONS—Osteoclasia. R. H. MORRIS—Club feet.

Friday

- Staff—9. Orthopedic clinic. S. M. FRYCKE—Cleidocranial dysostosis. F. R. OBER—Shelf operations. Sprengel's deformity. S. M. FRYCKE—Flexion deformity of the hips. A. T. LEOO—Coxa plana. J. W. SEVER—Obstetrical paralysis.
Staff—9.30 Operative clinic, surgery in infants and children.
W E LADD—1. Ulcerative colitis in childhood—diagnosis and treatment: demonstration of cases, lantern slide demonstration.
PATRICK J. MAHONEY—3.30. Treatment of fresh burns.
DONALD W. MACCOLLUM—2.45. Treatment of hemangioma by endothermy, demonstration of cases.
W E LADD—3. Surgical significance of pyuria in infancy and childhood, demonstration of cases, lantern slide demonstration.
T H LANZMAN—3.30. Malignant bladder tumors in childhood.

PETER BENT BRIGHAM HOSPITAL

Monday

- DAVID CHEEVER—1. Surgical clinic.
H F NEWTON—3. Thoracoplasty.
S. A. LEVINE—3.30. Circulatory emergencies in surgical patients.

Tuesday

- Staff—9. General surgery operative clinic.
E C CUTLER—2. Total thyroidectomy.
C. L. DEXTER—3. Symptoms and diagnosis of vascular thrombosis.
JOHN HOMANS—3.30. Swollen legs.

Wednesday

- Staff—9. General surgery operative clinic.
HENRY A. CHRISTIAN—2. Medical clinic.
M. C. SOMMER—3. Recent developments in diagnostic radiology.
E. S. EMERY JR.—3.30. Results of surgical procedures for relief of peptic ulcer.

Thursday

- Staff—9. General surgery operative clinic.
W C QUINCY—2. Indications for and results of total cystectomy.
J C ECKELS and G P GRABFIELD—3.30. Denervated kidney studied by means of the divided bladder.
M. S. STRACK—3. Methods of fixation of fractures of the jaw.
S B WOLFE—3.30. Demonstration of surgical pathology.

Friday

- Staff—9. General surgery, operative clinic.
DAVID CHEEVER—2. Cancer of the stomach.
F C NEWTON—2.30. Cancer of the rectum.
R. FITZ—3. Function of the spleen.
H P MORRIS—3.30. Treatment of pernicious anemia, motion picture demonstration.
F R OBER—3.45. Treatment of neuromuscular sequelae of pernicious anemia.

BOSTON CITY HOSPITAL

Monday

Staff—2. Dry clinic. J J REAGAN S WATSON, and D MURPHY. The eye in arteriosclerosis, hypertension and tumor. G A COOK. Treatment of shock. J RUSSELL and M RIVVO. Pellegri-Steda disease diagnosis and treatment. O J HERMANN and E PASTERNA. Synovitis of knee. F A STOWICK. Septic hips

Tuesday

DAVID D SCOTT, SOMER FRAZER, THOMAS W WATSON, and JOHN A SMITH—9. General surgical dry clinic

First surgical service—9. General surgical operative clinic. HORACE BRYNER. Thoracoplasty for unilateral phthisis. phrenicectomy for unilateral phthisis. JAMES J HILF. Repair of ventral hernia. gastric ulcer. GEORGE W PASTERNA. Chronic emphysema. cholelithiasis

Fifth surgical service—2. Dry clinic. JAMES J WATSON. Some surgical aspects of jaundice—hyperparathyroidism, end-results, repair of common duct chondromatous coma of humerus, end-result carcinoma of stomach, end-result ligation of common carotid artery, end result FRANCES F HENDERSON. Carcinoma of lung. pancreatitis, review of history. ANASTASIA KILIA. Prostate and eschelus as foci for retroperitoneal infection. kidney resection, demonstration of cases. CHARLES C FORD. Peripheral arterial embolism, results of operative treatment on fifteen cases. I. FURBERT O'NEIL. Breast tumors, benign versus malignant. WILLIAM A WATSON. Subject to be announced

ROBERT M GREEN, JOHN B WILLIAMS, FREDERICK L GOOD, JOSEPH P CONNOR and associates—9. Gynecological and obstetrical dry clinic. Treatment of intra-cervical peritonsillar abscess. pelvic inflammation

Wednesday

IRVING J WALLACE, FRANK F HENDERSON, CHARLES C FORD, E. I. FURBERT O'NEIL, and WILLIAM A WATSON—9. General surgery operative clinic

Bone and joint service—9. Dry clinic. OTTO J HERMANN. Boston City Hospital bone and joint service. THOMAS H PETERSON. Colles fracture therapy. Scatter traction in unreduced fractures of the forearm and old shoulder dislocations. GEORGE K COOK. Fracture of the olecranon, new operative repair. OTTO J HERMANN. Recurrent shoulder dislocations repaired by the Nicola method, end results, discussion. WILLIAM F COTTAGE and MARK H ROULES. Subclavicular burn. MARK H ROULES. Rupture of supraspinatus tendon, discussion. JOSEPH H SNOWELL. Spinal fracture therapy. RUSSELL F SULLIVAN. Spinal fusion. OTTO J HERMANN. Compound fracture therapy. FRANK W MURPHY. Anesthesia in fractures.

First surgical service—2. Dry clinic. NEWTON C BROWN. Results of treatment of Colles fracture. modern splinting methods in fracture therapy. JAMES J HILF. Results in treatment of peptic ulcer. giant-cell sarcoma of bone. treatment of ventral hernia. HOWARD BRYNER. Methods and results in treatment of acute emphysema, lung abscess, bronchiectasis, pulmonary tuberculosis. GEORGE W PASTERNA. Methods and results in treatment of chronic emphysema

Sixth surgical service—2. Dry clinic. JAMES W SPAN. Separation of femoral epiphysis. MARK H ROULES. Ankylosed hips. OTTO J HERMANN. Treatment of intracapsular fractures of neck of femur. demonstra-

tion of cases of recent fractures and ununited fractures. FREDERICK J COTTON. Pelvic fractures. JOSEPH H SNOWELL. Bone grafting. ROBERT M GREEN, JOHN B WILLIAMS, FREDERICK L GOOD, JOSEPH P CONNOR and associates—9. Gynecological and obstetrical operations

Thursday

OTTO J HERMANN, JOSEPH H SNOWELL, WILLIAM F COTTAGE, RUSSELL F SULLIVAN, THOMAS H PETERSON, and G. KENNETH COOPER—9. Operative bone and joint clinic. Ward rounds, demonstration of fracture apparatus, etc.

Second surgical service—9. ROBERT C COCHRANE. Total thyroidectomy for congestive failure and angina. para-thyroid tumors. WILLIAM R MORRISON. One hundred perforated ulcers of the stomach and duodenum from the Boston City Hospital stomach surgery. motion picture demonstration. demonstration of following cases—total removal of stomach for cancer with anastomosis of the jejunum to the esophagus, bow glass deformity of the stomach, cholecystectomy (formed by nature. THOMAS H PETERSON. Knee joint pathology. JOHN J LEE. Recurrent intranscription caused by intestinal tumor. carcinoma of the esophagus. RICHARD I SMITH. Pancreatitis. HERBERT H HOWARD. End results of bilateral renal tuberculosis. importance of postoperative treatment of postresected patient.

Fourth surgical service—2. Dry clinic. ARTHUR R. KEMP. Civilian gas gangrene tetanus. use of anesthetic liquid concentrate. cavernous sinus thrombosis of neck. catheter in common bile duct since 1925. ununited fractures. LEONARD HILF. Demonstration of cases. JOSEPH H SNOWELL. Colles fracture therapy. H. A. BOVIV. Acute traumatic abdomen.

Sixth surgical service—2. Bone and joint dry clinic. WILLIAM F COTTAGE. Gonorrheal arthritis of the knee. RUSSELL F SULLIVAN. Hallux valgus therapy. OTTO J HERMANN. Fractures of the olecranon therapy. discussion. JOSEPH H SNOWELL. Bone tumors. FREDERICK W O'NEIL. Pre- and postoperative X-ray therapy in malignant tumors of the bone. THOMAS H PETERSON. Tendon fractures. ROBERT M GREEN, JOHN B WILLIAMS, FREDERICK L GOOD, JOSEPH P CONNOR and associates—9. Obstetrical and gynecological operations

Friday

ARTHUR R KEMP, ROBERT C COCHRANE, WILLIAM R MORRISON, STEPHEN P MALLORY and V. H. LAVA JUAN—9. General surgery operative clinic.

Staff—9. Gynecological and obstetrical operations

Staff—2. Dry clinic. J J REAGAN and W B CASTLE. The eye in aneurysm patients. STEPHEN P MALLORY. Fractures of the jaw. WILLIAM R MORRISON. Visualization of arteries and veins for diagnosis and operation of aneurysm. ligation of the first part of right subclavian artery and subsequent ligation of innominate artery for arteriovenous aneurysm of internal jugular vein and subclavian artery. OTTO J HERMANN and WILLIAM R MORRISON. Chronic subluxation of sternal end of clavicle. STEPHEN J MADDOCK. Discussion of the Baer magnet treatment of chronic osteomyelitis.

Physiotherapy service—9. Dry clinic. JOSEPH RUSSELL. Electrodiagnosis. JOSEPH RUSSELL, GREGG W DICKINSON, ARTHUR J COLE, WALDO W ROBERTS, and SMILEY M. SNOW. Demonstration of cases and treatment.

MASSACHUSETTS GENERAL HOSPITAL

Monday

- Staff—2. Dry clinic. A W. ALLIEN. Bleeding peptic ulcer. JOHN STEWART. Water balance in the surgical patient. C. M. JONES. Nutritional edema. L. S. MCKITTRICK. Cancer of rectum. E. L. YOUNG, Jr. Cancer of colon. J. V. MELOS and F. W. HORT. Rupture of Graafian follicle and corpus luteum. R. H. WALLACE. Treatment of burns.
- W. J. MCKENZIE, JOHN HODGSON and associates—2. Neurosurgical clinic.
- V. H. KALANJIAN, E. M. DALAND and associates—2. Plastic surgery clinic.
- T. R. GORTHAUS and associates—4. Obstetrical clinic.

Tuesday

- Staff—9. Operative clinics. General surgical, genito-urinary and thyroid services.
- H. C. MARBLE and T. W. HARMER—2. Hand lesions.
- GEORGE HOLMES, A. O. HANFORD, and associates—2. Symposium on the roentgen ray.
- E. D. CHURCHILL and associates—2. Surgical research laboratories, demonstration of specimens and discussions.
- M. N. SMITH-PETERSEN and associates—2. Orthopedic clinic.
- Ether Day exercises—4.

Wednesday

- Staff—9. Operative clinics, general surgical, fracture and circulatory services.
- Staff—2. Dry clinic. D. KING. Postoperative pulmonary complications. H. BRADSHAW. Methods in anesthesia. H. SPRAGUE. Surgery in cardiac patients. L. S. MCKITTRICK and R. H. MILLER. Ulcerative colitis. E. D. CHURCHILL. Cardiomyopathy. E. B. BENEDICT. Gastroscopy. R. H. MILLER. Osteomyelitis.
- J. V. MELOS, F. ALLIBORTH and associates—2. Ovarian dysfunction clinic.
- P. D. WILSON, A. W. ALLIEN, G. A. LELAND and associates—2. Fracture clinic.

Thursday

- E. A. CONNOR and associates—9. Symposium on lesions of the shoulder.
- Staff—9. Operative clinics, general surgical and thoracic services.
- T. B. MALLORY—12. Clinical pathological conference.
- E. D. CHURCHILL, W. WHITTEMORE, and associates—2. Thoracic surgery clinic.
- A. W. ALLIEN and associates—2. Circulatory diseases clinic.
- C. C. SPENCER and associates—2. Tumor clinic; cancer symposium.

Friday

- Staff—9. Operative clinics, general surgical and orthopedic services, neurological operations, plastic surgery.
- Staff—2. Dry clinic. C. LYONS. Symbiotic infections. B. VINCENT and A. V. BOCK. Surgery of spleen. A. W. ALLIEN. Regional ileitis. R. H. MILLER. Tuberculosis of the lymphatic system. R. LUDLOW. Portal circulation. R. H. SMITH. Significance of negative Graham tests. OLIVER CORN. Subject to be announced. R. ROZINS. Pilonidal sinus.
- J. H. STAMPA, A. W. ALLIEN, E. D. CHURCHILL, R. H. MILLER, E. L. YOUNG, Jr. and associates—2. Diseases of the thyroid and parathyroid.
- J. D. BARNET and associates—2. Genito-urinary surgery.

FREE HOSPITAL FOR WOMEN

Tuesday

- F. A. PEMBERTON, G. V. SMITH and S. C. GRAVES—9. Operative and dry clinic. Carcinoma of cervix uteri. Treatment and results, prevention, diagnosis of early cases, relation to cervicitis and its treatment, complications of radium treatment, rebel of pain. Carcinoma of fundus uteri, treatment and results, classification, other tumors of uterus—fibroids, adenomyoma.

Wednesday

- F. A. PEMBERTON, G. V. SMITH, and PAUL YOUNG—9. Operative and dry clinic. Tumors of the ovary. Diagnosis, treatment, and results. Cystadenoma, granulosa cell tumor. Brenner tumor. Teratoma. Endometriosis, diagnosis and treatment. Tumors of tubes, round ligaments, and vagina.

Thursday

- G. V. SMITH and JOHN ROCK—9. Operative and dry clinic. Sterility diagnosis, treatment and results. Menorrhagia and metrorrhagia, diagnosis, treatment and results. Endocrine research. Dysmenorrhea.

Friday

- F. A. PEMBERTON, E. B. SHEERMAN, and S. C. GRAVES—9. Operative and dry clinic. Prolapse, procidentia, complete tear of perineum. Vesico- and rectovaginal fistulae. Krönleins valve, carcinoma vulvae. Trichomonas vaginitis, tumors of breast, value of X-ray treatment.

COLLIS P. HUNTINGTON MEMORIAL HOSPITAL

Monday

- Staff—2. 15. Tumors and diseases of bones, dry clinic. J. C. AUST. Calcium metabolism in diseases of the bones. CHANNING C. SHIMMONS. Malignant tumors of bone. RICHARD DRESTER. Radiological diagnosis of bone tumors and certain rare forms of skeletal diseases. C. C. FRANKLIN. The phosphatase content of the blood in bone tumors and skeletal diseases.
- GEORGE A. LELAND and J. V. MELOS—3. 30. Carcinoma of the cervix.

Friday

- Staff—2. 15. Carcinoma of the oral mucous membrane. Dry clinic. CHANNING C. SHIMMONS. Choice of treatment in the individual case. C. C. LUND. Results of treatment of cancer of lip. GRANTLEY W. TAYLOR. Carcinoma of the mouth in the female. RICHARD DRESTER. Radiation treatment of oral carcinoma. CHARLES B. HORTON. Prophylaxis of cancer of the mouth. SOMMER STURGIS. Electrical currents between fillings of different metals as an etiological factor in leukoplakia and carcinoma of the mouth.
- E. W. HERMAN and LEROY A. SCHALL—3. 30. Carcinoma of the accessory sinuses, tonsils, and larynx.

CAMBRIDGE HOSPITAL

Tuesday

- Staff—9. General surgical clinic.
- Staff—2. General surgery dry clinic.

Wednesday

- J. W. SEVER, S. S. HANFORD and M. G. KATZOFF—9. Fracture clinic.
- V. H. KALANJIAN—9. Corrective fracture clinic.
- Staff—2. Fractures, dry clinic.

NEW ENGLAND DEACONESS HOSPITAL

Tuesday

F H LARRY H M CLUTE, R B CATTELL and R H OVERBOLT—*g* General surgical operations
 GILBERT HORRAX and JAMES POPPER—*g* Neurosurgical operations
 RICHARD H OVERBOLT—*g* Thoracic surgery operations
 G E HAGGART—*g* Orthopedic operations
 JAMES B HICKS—*g* Urological operations
 LINCOLN F SORE, PHILIP E WOODBRIDGE, and URSAN EVERBOLT—*g* Anesthetics

F H LARRY—*g* Esophageal diverticulum, dry clinic
 GILBERT HORRAX—*g* Malignant exophthalmos, dry clinic
 Staff—*s* Dry clinics H M CLUTE Management of obstructive jaundice exploration of common duct GILBERT HORRAX Brain tumors, malignant exophthalmos SARA M JORDAN Gastric cancer and ulcer gastroduodenal ulcer F H LARRY Total gastrectomy for cancer gastroduodenal coarct fistula, surgery of intractable ulcer EVERETT KEEFER Hemorrhage in peptic ulcer RICHARD B CATTELL Embolotomy parathyroid tetany

Wednesday

F H LARRY H M CLUTE, R B CATTELL, and R H OVERBOLT—*g* General surgical operations
 GILBERT HORRAX and JAMES POPPER—*g* Neurosurgical operations
 RICHARD H OVERBOLT—*g* Thoracic surgery operations
 G E HAGGART—*g* Orthopedic operations
 JAMES B HICKS—*g* Urological operations
 LINCOLN F SORE, PHILIP E WOODBRIDGE, and URSAN EVERBOLT—*g* Anesthetics

Staff—*s* Dry clinics G E HAGGART Subiletoed bur-
 stis treatment of flexion deformities JAMES L POPPER End-results in trigeminal neuralgia, spinal fluid pressure dynamics FRANK H LARRY Esophageal diverticulum hyperthyroidism H M CLUTE End-results in hyperthyroidism LEWIS M HOBBS Thyrocardiac patients EVERETT KEEFER Ulcerative colitis RICHARD B CATTELL Surgical treatment of ulcerative colitis RICHARD OVERBOLT Limited thoracoplasty in pulmonary tuberculosis, cancer of lung

Thursday

E P JORDAN, H F ROOT L S McKITTRICK, and T C PRATT—*g* Surgical and medical diabetic ward rounds
 T C PRATT—*g* 30 Thigh amputation for diabetic gangrene
 L S McKITTRICK—*g* 30 Gritti Stokes amputation for diabetic gangrene

Staff—*s* Dry clinic Surgery in diabetes mellitus E P JORDAN Medical care of the surgical patient L RICHARDS Otolaryngological aspect of diabetes J H WATTS Carotid surgery in diabetes mellitus Gangrene and infection of the lower extremities H F ROOT preventive measures L S McKITTRICK factors influencing the level of amputation T C PRATT Indications for guillotine amputation R S THOMAS Obstetrics in diabetes MARK ROGERS Depressed fracture of the spine in diabetes subiletoed burnitis in diabetes mellitus

Friday

F H LARRY H M CLUTE, R B CATTELL, and R H OVERBOLT—*g* General surgical operations
 GILBERT HORRAX and JAMES POPPER—*g* Neurosurgical operations
 RICHARD H OVERBOLT—*g* Thoracic surgery operations

G E HAGGART—*g* Orthopedic operations
 JAMES B HICKS—*g* Urological operations
 LINCOLN F SORE, PHILIP E WOODBRIDGE, and URSAN EVERBOLT—*g* Anesthetics
 Staff—*s* Dry clinics R B CATTELL Cancer of the colon and rectum GILBERT HORRAX Root resection for trigeminal neuralgia cordotomy for pain JAMES POPPER Spinal cord tumors RICHARD OVERBOLT Cancer of the breast JAMES B HICKS Transurethral resection of the prostate H M CLUTE Subphrenic abscess F H LARRY and FRANK N ALLAN Parathyroid tumors

PALMER MEMORIAL HOSPITAL

Tuesday

Staff—*g* Treatment of malignant disease, including surgery electrosurgery and radium implantation, operative clinic
 Staff—*s* Dry clinics G A LELAND Carcinoma of cervix FLETCHER COLAN Urinary tract complications from carcinoma of the cervix L S McKITTRICK Internal radiation for carcinoma of the breast R H DRAKE Irradiation of the ovary in cancer of the breast GEORGE G SMITH Diversion of the urinary stream JOHN HODGSON Relief of pain in malignant disease

Wednesday

Staff—*g* Treatment of malignant disease including surgery electrosurgery and radium implantation, operative clinic

Thursday

Staff—*s* Dry clinics D F JONES Surgical management of carcinoma of the rectum L S McKITTRICK Factors favoring early diagnosis of cancer of the colon, principles of treatment R H SMITH Polyps of the colon SHELLE WARRER Pathological aspects of rectal polyps WYMAN RICHARDSON Blood dyscrasias after gastrectomy and short circuiting operations on the intestinal tract

Friday

Staff—*g* Treatment of malignant disease including surgery electrosurgery and radium implantation, operative clinic

PONDVILLE STATE CANCER HOSPITAL

Tuesday—s

ERNEST M DALAND The Massachusetts cancer program
 HENRY JACKSON, Jr. Some aspects of malignant lymphomas
 JOE V LEPUS Ovarian tumors
 LAWSON PARSONS Treatment of cancer of the cervix by X-ray followed by radium
 ROBERT GRAVES Cancer of the prostate with metastases
 CHARLES KICHMAN Cancer of the penis
 CHARLES DUKAK X-ray treatment of advanced skin cancer demonstration of cases

Friday—s

GRANTLEY TAYLOR Radium needles in cancer of breast
 HORATIO ROGERS Chronic cystic mastitis
 RICHARD DREMPER X-ray in the diagnosis of gastrointestinal cancer
 SHELLE WARRER Changes in tumor tissue caused by radiation
 JOHN HODGSON Treatment of pain in cancer patients
 CARL ERYAND Cancer of the strum, demonstration of cases

HARVARD MEDICAL SCHOOL

Monday

- G. KENNETH COOMEE and OTTO AUFRANC—3 (Bldg. C) Demonstration of the mechanical factors controlling the pulmonary circulation.
- CHARLES L. SCUDDER and associates—2 (Bldg. E) Symposium on fractures.

Tuesday

Building D—2

- GEORGE B. WISLOCKI. Studies in mammalian reproduction.
- VALY MENKIN. Some problems of inflammation related to surgery.
- HENRY G. SCHWARTZ. An experimental study of sympathetic reflexes.
- J. L. BREMER. The postnatal growth of the mammalian lung.
- HAROLD L. WEATHERFORD. The finer changes in the liver cells in anaphylactic shock.
- LESTER S. KING. Some aspects of the hæmato-encephalic barrier.

Building E—2

- G. A. BENNETT and WALTER BAUER. Joint changes resulting from trauma.
- HUGH K. WARD. Streptococcal infections.
- CECIL K. DRINKER. The physiology of the lymphatic system and its bearing on certain problems in surgery.

Wednesday

Building C—2

- HALLOWELL DAVIS. Effect of cerebral anemia on the electrical response of the cortex.
- M. I. GREGG. The use of hypertonic sacrose solution to reduce cerebrospinal fluid pressure without a secondary rise.
- WALTER B. CANNON. Some relations of the sympathetic nervous system to surgery.

Building B—2

- DAVID CHEEVER. Surgical anatomy of the abdomen: demonstration on cadaver.

Building E—2

- FRANK OBER and associates. Orthopedic problems from Children's Hospital. A. H. BREWSTER. Scoliosis. J. KUNN. Posture and postural scoliosis. P. NORTON. Posterior transplants. H. FRIEDMAN. Congenital deformities.

Thursday

- CHARLES L. SCUDDER and associates—2 (Bldg. E) Symposium on fractures.

Friday

Symposium on Industrial Surgery—2—Building C

- JOHN D. ADAMS and W. A. ROGERS. Injuries of the back.
- HENRY MARBLE, F. J. COTTON and J. D. ADAMS. Injuries of the nervous system.
- F. J. COTTON and J. H. BURNETT. Colles' fracture.

Orthopedic Clinic—2—Building E

- W. GREEN. Osteomyelitis in infants and children.
- R. H. MORRIS. Septic hips with involved heads.
- A. T. LEO. Osteomyelitis of the tarsus.
- R. JOPLIN. Multiple myeloma.
- A. H. BREWSTER. Peroneal spasm.
- R. H. MORRIS. Knee flexion.

Daily

Warren Museum—M. Canavan, Curator—2

- Demonstration of Dwight collection of spines illustrating deformities, anomalies, diseases. Bone tumors, with X rays, histories, and microscopic slides, with microscopes available for examination (some of these specimens were used in the illustrations in the monograph on "Bone Sarcoma" issued by the American College of Surgeons). Models showing various types of club feet and effects of operation. Pictures illustrating pathological conditions of bone in Dr. Nichols' collection. Fractures and dislocations of bones as they existed before industrial plants provided so many safeguards. Tuberculous of bones and joints. Syphilis of bones. Dislocation of ends of bones. Collection of old surgical instruments, obstetrical forceps, turnkeys for extracting teeth, urological tools, cupping and leeching instruments.

NEWTON HOSPITAL

Tuesday

- E. D. LEONARD—9. Breast amputation.
- G. M. MORRISON—9. Reconstruction of elbow.
- G. K. COOMEE—9. Operation for fractured patella.
- E. G. CRABTREE—9. Cystotomy.
- F. W. MARYIN—9. Pantocain anesthesia.
- D. G. NUTTER—9 15. Dermoid cysts of the abdomen.
- R. I. SMITH—9 30. Carcinoma of the duodenum.
- G. C. PRATHER—9 30. Renal calculus.
- N. P. BRACKETT—10. Strangulated hernia in the aged.
- D. G. NUTTER—10. Hysterectomy for fibroids.
- G. K. COOMEE—10. Triceps repair of olecranon fracture.
- G. M. MORRISON—10. Ankle fractures.
- F. R. CLARK—10. Cesarean section.
- H. WATERS—10 15. Intussusception in infancy.
- D. G. WILCOX—10 30. Prostatectomy.
- E. D. LEONARD—10 45. Paralytic ileus.
- R. I. SMITH—11. Complete thyroidectomy for angina pectoris.
- N. P. BRACKETT—11. Cholecystectomy.
- H. G. DUMPHY—11. Ligation of saphenous vein for varicose ulcer.

- Fracture and orthopedic services—9. Dry clinic. Demonstration of application of plaster casts, Boehler technique application of Anderson well leg traction apparatus, treatment of fractures of the spine, including hyperextension, frames, jackets, etc. treatment of Colles' fracture by Cotton-Loder method demonstration of new type humeral traction abduction splint.
- Staff—2. Symposium on obstetrics. E. GRANVILLE CRABTREE. Discussion of urinary tract infection in pregnancy. GEORGE C. PRATHER. Discussion of loose kidneys in pregnancy. F. R. CLARK, M. F. EADIE, and G. E. MAY. Pre and postoperative care of patients.
- ROBERT G. VANCE—2. X rays of traumatic skulls.

CARNEY HOSPITAL

Daily

- F. B. LUND and associates—9. General surgical operations.
- L. E. PRAXEUR and associates—9. Gynecological and obstetrical operations.
- W. R. MACAULAND and associates—9. Orthopedic operations.
- R. S. GRAVES and associates—9. Urological operations.
- Staff—2 15. Dry clinics.

BETH ISRAEL HOSPITAL

Monday

Staff—2:30 Dry clinic J. S. RABIN. Prophylactic vein ligation against embolism from phlebitis of the internal saphenous vein. M. BLOOMFELD. The prevention of scar tissue by use of bandage, experimental and clinical experiences, demonstration of cases. W. LEVINSKY. Intraperitoneal adhesions. L. HENKINSON. Transfusions during active bleeding from peptic ulcer. A. THURMAN. Surgical treatment of cholecystitis. J. MINK. Subacute pancreatitis. J. FINE. Postoperative distension, an experimental study.

Tuesday

Staff—9. Symposium on total thyroidectomy for chronic heart diseases and angina pectoris. H. BLUMHART. Rationale of total thyroidectomy in chronic heart disease. J. RABINMAN. End results of total thyroidectomy in angina pectoris. D. D. VAN. End results of total thyroidectomy in congestive heart failure. H. BLUMHART. Indications and contra-indications for surgery selection of cases. C. G. MITCHELL. General surgical considerations in total thyroidectomy. D. BELLER. Technical considerations in total thyroidectomy. DONATH. GILMAN. Postoperative parathyroid tetany. D. DAVIS. Treatment of postoperative complications. J. FINE. A technique for relief of temporary lateral recurrent nerve injury. A. WEINSTEIN and M. ALTMAN. Total thyroidectomy motion picture demonstration demonstration of cases. C. G. MITCHELL and associates—2. Surgical operations including total thyroidectomy.

Wednesday

C. G. MITCHELL and associates—3. Surgical operations. Staff—9:30 Dry clinic. W. DANKERT. Blood changes in surgical conditions. Dr. MOSKOW. Medical conditions simulating surgical disease. Dr. DEWOL. Significance of postoperative rise in postoperative nitrogen. ARNOLD STARR and Dr. MITCHELL. Postoperative renal suppression. C. G. MITCHELL. Surgery of the large intestine. S. CAMILLI and Dr. FALCOV-LERMAN. Thyroid clinic experiences, demonstration of cases. E. G. CHARTER and associates—9. Dry clinic, genitourinary surgery. Symposium on the female bladder. Demonstration of various factors related to function in health, pregnancy and disease, use of urethrogram and cystogram in diagnosis of bladder displacements and deformities in the multiparous woman, results of routine surgery treatment of infections in the abnormal bladder. Staff—3. Dry clinic. C. BRANKE. Acute appendicitis beyond age of fifty. W. J. MITCHELL. Subject to be announced. B. RAPAPORT. Comparison on postoperative complications following spinal and general anesthesia. J. FINE. Relation of diaphragm to the efficiency of cough. L. NARON. Gas bacillus infection complicating laparotomy. B. BAKEL. Differential diagnosis of jaundice. Dr. JAMNITZKY. Indications for ileostomy in ulcerative colitis. C. G. MITCHELL. Regional ileitis. M. BARON. Is radical resection for carcinoma of rectum the best procedure?

Thursday

Staff—9. Symposium on total thyroidectomy for chronic heart disease and angina pectoris. H. BLUMHART. Rationale of total thyroidectomy in chronic heart disease. J. RABINMAN. End results of total thyroidectomy in angina pectoris. D. DAVIS. End results

of total thyroidectomy in congestive heart failure. H. BLUMHART. Indications and contra-indications for surgery selection of cases. C. G. MITCHELL. General surgical considerations in total thyroidectomy. D. BELLER. Technical considerations in total thyroidectomy. DONATH. GILMAN. Postoperative parathyroid tetany. D. DAVIS. Treatment of post-operative complications. J. FINE. Technique for relief of temporary bilateral recurrent nerve injury. A. WEINSTEIN and M. ALTMAN. Total thyroidectomy motion pictures, demonstration of cases.

C. G. MITCHELL and associates—2. Surgical operations including total thyroidectomy.
E. G. CHARTER and associates—2. Bladder surgery operative and dry clinic.

Friday

C. G. MITCHELL and associates—9. General surgical operations.
W. J. MITCHELL—9. Craniotomy.
MARK H. ROBINSON and associates—9. Orthopedic dry clinic. Manipulation of subdeltoid bursitis, methods and results. Slipping epiphysis, femoral neck club foot, demonstration of application of plaster cast method of drainage of septic knees, posterior incision steoscopy, tenosynovitis, operative results. Nicola operation, end-results in cases of recurrent dislocation of shoulder, marble bones, repeated fractures of femur, fractures of long bones in Paget's disease, compression fractures of spine in diabetes and old age, correction of hallux valgus, temporary paralysis of sensory nerve affecting the joint.

I. G. C. ABTELL and associates—2. Renal surgery. Staff—2. Symposium on tumors. WILLIAM DANKERT. Malignancy of blood forming organs. L. M. FREEDMAN and H. F. FREEDMAN. Laryngeal carcinoma, diagnosis and treatment presentation of cases. R. DAVIDOFF. C. G. MITCHELL, and H. F. FREEDMAN. Breast tumors, differential diagnosis, surgical and radiation treatment. Dr. SCHLESINGER. Diagnosis of malignancy from sputum and pleural fluids. H. F. FREEDMAN and R. DAVIDOFF. Policy toward married women in regard to carcinoma of the uterine cervix. S. A. ROBINSON, E. G. CHARTER, and G. E. PRATHER. Renal tumors, roentgen diagnosis, surgical treatment, results. G. E. PRATHER. Testicular tumors. J. H. SCHWARTZ and H. F. FREEDMAN. Carcinoma of the skin, diagnosis, motion picture demonstration of radium treatment.

Daily Exhibit in Medical Research Laboratories

Blood changes in surgical conditions, total thyroidectomy for chronic heart disease, renal function tests in surgery demonstration of interesting and unusual X-ray films, surgical pathological specimens with case histories, photographs, etc.

LONG ISLAND HOSPITAL

Wednesday

R. H. MORRIS and T. H. PETERSON—9. Fracture clinic. Fracture of the neck of the femur in elderly people—demonstration of Scudder traction apparatus.
H. R. VETTER—9. Neurosurgical diagnosis.
J. H. CONNOR and C. S. SWAN—9. Urological operations.
A. S. McMICHAEL—2. X-ray demonstration.
I. B. AXERSON—2. Pathological demonstration.
C. L. SWAN, R. I. SMITH, and T. C. PRATT—2. General surgical operations.

ST ELIZABETH'S HOSPITAL

Tuesday

- JOSEPH STANTON—9 Subtotal thyroidectomy
 GEORGE KEENAN—9 Hysterectomy
 CHARLES KICKHAM—9 Supravaginal hysterectomy
 E J O'BRIEN—9 Transurethral resection of prostate gland
 E M HODGKINS—10 Repair of postincisional hernia with peritoneal fascial strips, by utilizing sac.
 JOHN SPELLMAN—10 Radical operation for cancer of tongue

- THOMAS BRODERICK—10 Spine fusion
 BENEDICT BOLAND—11 Low transverse cervical section.
 LAURENCE LOUIS—11 Total thyroidectomy
 Staff—8 Dry clinic. CHARLES KICKHAM Series of spontaneous rupture of the uterus. RUSSELL SULLIVAN End-results of bone and joint problems. LAURENCE LOUIS Postoperative total thyroidectomy for (a) angina pectoris, (b) congestive heart disease. FRANCIS P MCCARTHY Frozen sections demonstration and discussion of pathological specimens

Wednesday

- JOSEPH STANTON—9 Hysterectomy
 GEORGE KEENAN—9 Cholecystectomy
 RUSSELL SULLIVAN—9 Nicola operation for recurrence of dislocation of shoulder
 LAURENCE LOUIS—9 Radical operation, cancer of breast
 E J O'BRIEN—10 Nephrectomy for tuberculous kidney
 WILLIAM McDONALD—10 Operation for correction of childhood injury

- THOMAS BRODERICK—10 Reconstruction of hip joint
 M McGARTY—10 Removal of cartilage from knee joint
 EDWARD HODGKINS—11 Repair of recurrent inguinal hernia with fascial strips

- MARTIN SPELLMAN—11 Sacro-iliac arthrodesis
 Staff—3 Dry clinic. WILLIAM DOLAN Industrial surgery. JOHN WINDISKEY Diseases of the gall bladder medical cases either refusing operation or being surgically unfit, demonstration of cases. FRANK JANTEEN Cholecystitis and liver dysfunction (a) with hypopituitary syndrome, (b) with hypothyroid syndrome. MICHAEL MCGARTY Flap graft in reconstruction of foot. JOHN CAREY Disease of spleen from a surgical standpoint. THOMAS BRODERICK Demonstration of spinal cases with operative technique, lantern slides

Thursday

- JOSEPH STANTON—9 Gastro-enterostomy
 BRYANT WETHERELL—9 Nephrectomy
 FRANK JANTEEN—9 Inguinal herniotomy under local anesthesia
 EDWARD HODGKINS—9 Gastro-enterostomy
 THOMAS BRODERICK—10 Reconstruction of hip joint
 CHARLES KICKHAM—10 Prolapsed uterus with perineal repair and suspension

- WILLIAM DONOVAN—10 Suprapubic prostatectomy
 EDWARD O'BRIEN—10 Suprapubic cystostomy
 MICHAEL MCGARTY—11 Fascial repair of double recurrent inguinal hernia.

- BENEDICT BOLAND—11 Tubal plastic for sterility
 Staff—2 Dry clinic. WILLIAM O'HALLORAN Medicine from a pre-operative and postoperative standpoint. BRYANT WETHERELL Discussion of diagnosis of carcinoma of bladder. WILLIAM McDONALD Polyhydramnios in pregnancy. JAMES LYNN Vulval phlebitis complicating pregnancy antenatal. JOSEPH STANTON Hypocalcemia of unusual origin, gastric ulcer—demonstration of interesting clinical cases.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

Tuesday

- Staff—9 Surgical operations.
 Staff—2 Dry clinic. Carcinoma of fundus in young woman treated for amenorrhea with antuitrin-S. Fibrosarcoma of liver in six year old child. Carcinoma of kidney with metastasis in three year old child. Unusual pathological specimens with case histories.

Wednesday

- Staff—9 Surgical operations.
 Staff—9 Obstetrical analgesia demonstration of cases ward rounds prenatal clinic parent teaching clinic

Thursday

- Staff—9 Surgical operations
 Staff—9 Orthopedic operations, demonstration of unusual case of fractured pelvis
 MIRIAM KATZOFF—9 Familial muscular dystrophy

Friday

- Staff—9 Surgical operations.

ROBERT B BRIGHAM HOSPITAL

Monday

- L M SPEAR—2 Classification of types of arthritis
 L T SWAIN and J KUMINS—3 Treatment and orthopedic principles involved in arthritis.

Tuesday

- H K THOMPSON—2 Clinical analysis of arthritis with reference to classification and treatment
 P D WILSON and S ROBERTS—3 Discussion of operative procedures, demonstration of end-results

Wednesday

- L M SPEAR—2 Classification of types of arthritis
 L T SWAIN and J KUMINS—3 Treatment and orthopedic principles involved in arthritis

Thursday

- H K THOMPSON—2 Clinical analysis of arthritis with reference to classification and treatment
 P D WILSON and S ROBERTS—3 Discussion of operative procedures, demonstration of end-results.

CHELSEA MEMORIAL HOSPITAL

Thursday

- Staff—9 Dry clinic. CHARLES P SHEDDEN Septic abortions. LILWELLYN H. ROCKWELL Perforated duodenal ulcer. GEORGE A. MARKS Acute appendicitis with peritonitis. SYLVESTER B. KELLEY Causes of death in prostatitis.

- Staff—2 General surgical operations
 Staff—2 Dry clinic. GORDON MORRISON Abdominal trauma. STEPHEN G. JONES Volkmann's contracture. ALEXANDER P. AITKEN Epiphyseal separation of the radius. JOHN S. HODGSON Fractures of the skull. Discussion by FREDERICK J. COTTON.

SYMMES ARLINGTON HOSPITAL

Tuesday

- F J COTTON—9 Bone and joint surgery
 A. L. BRETT—9 Tumor of the spinal cord shoulder arthrodesis.
 G. P. TORLE—9 General surgery
 S. G. JONES—9 Volkmann's paralysis.

BOSTON DISPENSARY

Tuesday

Tumor clinic staff—*o* Dry clinic FRANK W. MARVIN. Anesthetics in operative cases. CHARLES M. PROCTOR. Precancerous and benign lesions of the oral cavity. CHARLES E. DUMAS. Radiation technique in malignancy of the throat. LEROY A. SCHALL. Treatment of cancer of tonsil. GEORGE S. SPARK. Malignant degeneration of sebaceous cysts. LOUIS E. PRANKIN. Precancerous lesions and cancer of the cervix, lantern slide demonstration. ALICE ETTINGER. Early diagnosis of malignancy of gastro-intestinal tract by resect method. HAROLD A. CHAMBERLIN. Papillary tumors of the kidney pelvis. ROGER C. GRAY. Management of cancer of penis with particular reference to a modified operation for advanced cases. MIRON J. HART. Cancer of the prostatic capsule. LEONARD OKER. Management of malignancy of the lymphatic system. HERBERT F. DAY. Cancer of breast, end results of dismastectomy and personal cases. JOSE ROSSIGNOL. Bleeding carcinomas of breast without tumor. WILLIAM M. SEIDENBERG. Management of cancer of rectum with particular reference to irradiation. HAROLD McMARSH. Relation of pathology department to tumor clinic.

Wednesday

Staff—*to* Dry clinic OLIVER G. TIVELAND. Clinical teaching of third year medical students. FRANCIS P. BARNUM. Use of adhesive plaster. P. A. CORNELL. Adenomatous changes in aberrant thyroid. HERBERT F. DAY. Management of a varicose vein clinic, where over 50 treatments a week are given. EDWARD T. WATKINS. Varicose veins, demonstration of cases and treatment. WALTER S. LAYTON. High ligation of varicose veins. WILLIAM M. SARTORI. Injection treatment of aneurysms. S. SYMONS HOLLICK. Results of multiple injections of varicose veins at same visit. HERBERT F. DAY. Results of evulsion of sloughs following injection treatment.

Thursday

Staff—*o* Dry clinic JOSEPH D. ADAMS. Shoeller-Christian disease (enchondromatosis), bone tumors. ROY E. MARRIS. Chondroma and chondrosarcoma. WILLIAM A. HINTON. Detection of syphilis as an aid in practice of surgery. FRANCIS M. TRIGRAM. Syphilis and the differential diagnosis of surgical conditions. JOSEPH S. LEBELL. Ophthalmic studies in syphilis. GRACE E. ROCKFORD. An unusual gynecological condition. LOUIS A. O'CONNOR. Pain in the shoulder girdle. ROBERT W. BECK. Kidney function renal function tests. WILLIAM I. DAVIS. Some observations in treatment of peptic ulcer in out-patient clinic. ALICE ETTINGER. Diagnosis of activity of duodenal ulcer by X-ray. KATHERINE S. ANDERSON. Hilaris hernia. HERBERT F. DAY. Solitary gall-stone pain relieved by posture. Demonstration of interesting X-ray plates of peptic ulcer and gall-bladder disease.

HARVARD UNIVERSITY

(Dillon Field House, Soldier's Field)

Opposite Harvard Stadium, Allston, Mass.

Wednesday

Augustus Thompson, Jr.—*a* Care and prevention of traumatic injuries in athletics, demonstration of protective strapping, padding, and apparatus used in modern athletics.

CAMBRIDGE CITY HOSPITAL

Tuesday

H. H. GERMANN, D. F. MARSH, E. J. O'BRIEN, L. D'ERRICO and E. DOWNEY—*o* Dry clinic. H. H. GERMANN. Results in surgery of the shoulder nerve suture, partial rupture of posterior cord of brachial plexus, fascial graft for recurrent dislocation of shoulder. Arthroplasty of shoulder. Arthroplasty for ankylosis of temporomandibular articulation, skin graft for extensive burns. D. F. MARSH. End-results in fracture of pelvis and humerus. E. J. O'BRIEN. End-results in transurethral resection of the prostate. Massive diverticulum of the bladder in a child 2½ years old. E. J. O'BRIEN. X-ray films of injuries to the head and spine. B. A. GOVERN and WALDO ROSSIGNOL. Orthopedic clinic end-results in fracture of hip. E. D'ERRICO. Results in injection treatment of aneurysms, moving picture demonstration. E. DOWNEY. Injection treatment of hemorrhoids, methods used and demonstration of cases.

Wednesday

H. H. GERMANN—*o* Surgical operations. Demonstration. Numbum operation for leg ulcer (cases), tumor of the parotid (3 cases). Staff—*o* Dry clinic MAXWELL MACDONALD. Encephalography as an aid to diagnosis in cerebral lesions. F. G. MORTIMER and T. E. DYMAN. Results of accessory sinus operations, demonstration of cases. R. D. YOUNG. Cesarean section. F. J. LYNN. To be announced. J. J. MURPHY. Treatment problems of burns in general hospital. J. W. ROCKFORD. Oral surgery operations. ARTHUR SARGENT and WILLIAM LARSON. Orthopedic and fracture clinic. F. O. O'BRIEN. Traumatic spine and head injuries, demonstration of X-ray films. J. W. ROCKFORD and F. McLEAN. Fractures of lower and upper jaw. M. SARA. Arthroplasty of lower jaw. E. J. O'BRIEN and L. ROCKFORD—*to* *o* General surgical operations. E. D'ERRICO—*a* Acute torsion of great omentum, appendicitis complicating pregnancy.

Thursday

D. F. MARSH—*o* General surgical operations. J. J. MURPHY—*o* *o* General surgical operations, problems of rupture of urethra, fracture of pelvis and fracture of femur. F. O. O'BRIEN—*a* Traumatic spine and head injuries, demonstration of X-ray films.

MASSACHUSETTS WOMEN'S HOSPITAL

Thursday

HENRY T. HUTCHINS—*o* Panhysterectomy. STEPHEN RUBINER—*o* Plastic laparotomy. WILLIAM A. WHITE, JR.—*o* Laparotomy. REGINALD MARSH—*o* Transverse cervical cesarean section. ROBERT L. MARSH—*o* Thyroidectomy. Staff—*a* Dry clinic CHARLES H. LAWRENCE. Endocrine sterility and results. DONALD MACOMBER. Problems of sterility. CHARLES F. PAINTER. Congenital obturator dislocation of right hip. Causes of absorption of bone. J. STEWART ROBERTS. Pathological specimens.

BEVERLY HOSPITAL

Thursday

PETER JOHNSON and JOSEPH ADAMS—*o* Fracture clinic.

FAULKNER HOSPITAL

Wednesday

- F J COTTON E G BRACKETT and associates—9 Bone and joint clinic, operative and dry
 Staff—2 Dry clinic E G BRACKETT Hip fracture
 F J COTTON Bone tumors, fractures of pelvis
 H C MARBLE Hand surgery: fractures of the forearm J D ADAMS Industrial lesions of the knee
 WILLIAM A ROULEX Compression fracture of spine
 E A COOMAN Shoulder lesions B GOOVIN On call
 fractures W F COTTON Ankle fractures
 H K SOWLES Elbow fractures Demonstration of X ray plates and pathological specimens.

Thursday

- E L YOUNG JR R C COCHRANE, A R KINGTON and associates—9 Operative clinic.
 J R TORBERT and R S TITON—11 Obstetrical clinic
 S W WIGG—11 Postoperative pulmonary complications
 Staff—2 Symposium on pre-operative immunization of the peritoneal cavity H L JAMESON Theoretical and experimental evidence of the benefit of amfetin
 E L YOUNG JR and EVERETT O'NEIL Clinical evidence of immunity from amfetin injection. R C COCHRANE and BURTON HAMILTON Total thyroidectomy for heart disease F G BALCH, Jr Injection treatment of hemorrhoids

EVANGELINE BOOTH MATERNITY HOSPITAL

Wednesday

- A K PAINE, H S FINKEL, W J McDONALD, M G BERLIN J HUPPES, D GOLDFARB, A A LEVI J J CONWAY H BAKER, S OGDON, and R T PHILLIPS—9 Gynecological operations and obstetrical procedures.
 Staff—2 A review by demonstration, charts, pictures, and exhibits, of the obstetrical experience of the Booth Hospital. Maternal mortality factors responsible for the declining rate at the Booth Hospital: the bleeding cases, statistics, management, and results: obstetrical sepsis, anesthesia, analgesia, and anesthesia in labor: results from the standpoint of safety efficiency effects on operative incidence cesarean section, incidence, indications, and mortality: toxemia of pregnancy: treatment methods and results over a fourteen year period, "debunking" pelvimetry: heart disease complicated by pregnancy: fetal mortality analysis of four hundred cases, pathology

INDUSTRIAL SURGERY

Tuesday

- H C MARBLE and H P TOWLE (141 Berkeley Street)—9
 D LYNN and B GOOVIN (245 State Street)—9

Wednesday

- G W MORSE (31 St. James Avenue)—9

Thursday

- WILLIAM DOLAN (110 Milk Street)—9

Friday

- J H SHOOTELL (260 Tremont Street)—9
 D LYNN and B GOOVIN (245 State Street)—9

MASSACHUSETTS MEMORIAL HOSPITAL

Daily

- Staff—9 Operative clinics
 Staff—2 Dry clinics.

NEW ENGLAND BAPTIST HOSPITAL

Tuesday

- HALSEY B LONER—9 Operative clinic.
 Staff—9 Dry clinics HALSEY B LONER Portal thrombosis, ulcerative colitis gall stones, pancreatitis, uterine fibroids. A A HORNOR Ulcerative colitis. ROBERT L. DE NORMANDIE and DELOS J BARSTON Blood transfusion in obstetrics management of borderline obstetrical cases anesthesia and analgesia in obstetrics prevention of eclampsia

Thursday

- F H LANEY H M CLUTE, R B CATTELL, and R H OVERHOLT—9 General surgery operative clinic.
 GILBERT HORRAX and JAMES PORTER—9 Neurosurgical operations.
 G E HACKETT—9 Orthopedic surgery
 JAMES B HICKS—9 Urological surgery
 LINCOLN F SIXX PHILIP D WOODBRIDGE, and URBAN EVERSOLE—9 Anesthesia

BOSTON LYING IN HOSPITAL

Tuesday and Thursday

- FREDERICK C IVERSON and associates—9 Obstetrical operations demonstrations of premature surgery, X ray department, research laboratories, and hospital wards
 FREDERICK C IVERSON and associates—2 Dry clinic Fetal roentgenometry anemia in pregnancy treatment of heart disease in pregnancy treatment of diabetes in pregnancy management of neglected cases of cephalopelvic disproportion treatment of placenta previa separation of the symphysis pubis, kidney function tests in pregnancy classification of the albuminuria and hypertensive conditions in pregnancy factors which make for viability in premature infants erythroblastosis fetalis, barbiturates and other analgesic drugs in labor

MALDEN HOSPITAL

Wednesday

- L E PRANTOFF and N A GALLAGHER—9 Gynecological operations
 R SULLIVAN—9 Orthopedic clinic.
 L W McQUIRK—9 Amoebic dysentery and its complications.
 C F LYNN, D J DUGGAN, I J WALKER and F W GAY—2 Surgical operations.
 Staff—2 Dry clinic. J S ROONEY Pathological demonstration. I J WALKER Discussion of jaundice with demonstration of liver specimens L SILVA Discussion of coronary and gall-bladder disease in middle-aged people with electrocardiographic tracings C H STAPLES Hyperparathyroidism, demonstration of cases

STATE PRISON COLONY

Daily to be announced

- HILBERT DAY Practice of medicine in a modern correctional institution.
 WILFRED BLOOMBERG Psychiatric approach to prison medicine.
 HENRY R. CRANO Unusual incidence of peptic ulcer in a prison population.
 GEORGE H. LYONS Minor surgical injuries in a protected population.
 GEORGE ROTHBLATT Dental conditions causing personality changes

WALTHAM HOSPITAL

Friday

- R. L. DENORMANDIE, T. W. HARMER, D. MUNRO, J. D. BARNETT, J. W. SEVER, H. Q. GALLUPP, R. COLLINS, and H. A. WOOD—*a*. Surgical operations
 R. L. DENORMANDIE, T. W. HARMER, D. MUNRO, J. D. BARNETT, J. W. SEVER, H. Q. GALLUPP, R. COLLINS, and H. A. WOOD—*a*. Dry clinics General surgery orthopedics, obstetrics, pathology etc

LAKELAND SANATORIUM

Wed. today

- Z. B. ADAMS—*a*. 30 Ankylosis of hip, operative Ward rounds
 Staff—*a*. Dry clinic Tuberculosis of lymph nodes, genitourinary tract eye gastro-intestinal tract, peritonaeum, and skin
 Z. B. ADAMS—*a*. Orthopedic dry clinic

SURGERY OF THE EAR, NOSE AND THROAT

MONDAY

- H. DAVIS, H. A. DENORMANDIE, and M. H. LUTKE—Harvard Medical School, Bldg. C—*a*. Physiological experiments on the hearing of animals with the technique first reported by Wever and Bray, report of the pathological conditions found in animals with abnormal hearing, demonstrating technique and apparatus used, physiological experiment conducted on animal with the apparatus used, demonstrating (1) auditory response obtained from the cochlea itself (2) auditory response from the cochlear nerve and its various ganglion centers in the medulla (3) auditory response as obtained from the cortex of the animal in the temporal lobe (4) the effect of anesthetics on these electrical responses, (5) demonstration of masking of tones in the cochlea
 F. E. GARLAND—Harvard Medical School, Bldg. B. Demonstration of historical instruments

TUESDAY

- Staff—Massachusetts Eye and Ear Infirmary—*a*. Operations and demonstration of cases
 WALTER B. HOOVER—New England Deaconess Hospital—*a*. Outcome of various laryngeal and tracheal complications of thyroid surgery Lingual tonsils and lateral bands of pharyngeal lymphoid tissue syndrome of adenoids, glossitis, and dysphasia
 JOSEPH W. ROCKWELL and THOMAS E. DYMAN—Cambridge City Hospital—*a*. Tonsillectomies with gas-oxygen anesthesia presentation of cases of lateral sinus thrombosis
 F. G. MINOTTA and associates—Carney Hospital—*a*. Operation and demonstration of cases
 WILLIAM T. HALEY—St. Elizabeth's Hospital—*a*. Operation for correction of dislocation of nasal septum
 H. P. MONROE—Harvard Medical School, Bldg. B—*a*. Exhibition of anatomical cases demonstrating the anatomy of the nose and throat, discussion of teaching methods demonstration on the cadaver of the submaxillary approach for deep pus in the neck P. E. MULLER and M. H. LUTKE Exhibition of specimens illustrating the anatomy of the ear
 Staff—Beth Israel Hospital—*a*. L. M. FREEDMAN Experiences with vocal cord paralysis in thyroidectomy D. J. FINE Technique for relief of bilateral recurrent nerve injury CHARLES GETTYS Studies on galvanism in vestibular tests L. M. FREEDMAN Jugular phlebotomy in mastoiditis S. CLINE Tuberculosis laryngitis and its treatment S. GARTIN Treatment of malignant tumors of the upper respiratory tract L. M. FREEDMAN Bronchoscopic studies
 F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room Demonstration of historical instruments

WEDNESDAY

- Staff—Massachusetts Eye and Ear Infirmary—*a*. Operations and demonstration of cases
 WALTER B. HOOVER—New England Deaconess Hospital—*a*. Operations
 HARRY J. DUNN and associates—Boston Dispensary—*a*. Dry clinic LOUIS WOLFE Bronchoscopy in the upright position as an out-patient procedure A. I. COHEN, F. S. DUNN and FRANK STERN An improved method of skin testing in allergic disturbances of nose and throat
 Staff—Children's Hospital—*a*. LYMAN RICHARDS Acute laryngotracheobronchitis MARGARET EVANS Bilateral jugular ligation and its neurological complications PHILIP MYERS Cerebral abscess CHESTER MILLS Sarcoma JOSEPH E. QUINCY Radical mastoid operation CHARLES ALLMAN Unusual foreign bodies ELMER GRUBBS Complications in simple tonsillectomy SAMUEL CLINE Cases of simple thrombosis
 F. G. MINOTTA and associates—Carney Hospital—*a*. Operations and demonstration of cases
 JOHN BURKS—St. Elizabeth's Hospital—*a*. Radical tonsil operation under nitrous oxide
 F. E. GARLAND—Harvard Medical School, Bldg. B. Demonstration of historical instruments

THURSDAY

- Staff—Massachusetts Eye and Ear Infirmary—*a*. Operations and demonstration of cases
 WALTER B. HOOVER—New England Baptist Hospital—*a*. Operations
 E. J. BUTLER and C. H. ALLMAN—Cambridge Hospital—*a*. Operative and dry clinic Hematogenous infection of left mastoid with extralabyrinthine abscess in a nine months old child pneumococcus type III meningitis with labyrinthitis, demonstration of case
 F. G. MINOTTA and associates—Carney Hospital—*a*. Operations and demonstration of cases
 C. FAUPEL—Faulkner Hospital—*a*. Operations and demonstration of cases
 WILLIAM T. HALEY—St. Elizabeth's Hospital—*a*. Radical operation for maxillary antrum
 JOHN BURKS—St. Elizabeth's Hospital—*a*. Radical mastoid operation
 F. E. GARLAND—Harvard Medical School, Bldg. B. Demonstration of historical instruments

FRIDAY

- Staff—Massachusetts Eye and Ear Infirmary—*a*. Operations and demonstration of cases
 WALTER B. HOOVER—New England Deaconess Hospital—*a*. Operations
 F. G. MINOTTA and associates—Carney Hospital—*a*. Operations and demonstration of cases

Staff—Massachusetts Eye and Ear Infirmary—1. Dry clinic. H. P. CARRILL. The present status of brain abscess from the standpoint of the otologist. P. E. MEISTER. A twelve year summary of cases of lateral sinus thrombosis at the Infirmary. P. MYERS. A ten year review of cases of labyrinthitis at the Infirmary. D. C. SMITH. Chest cases requiring bronchoscopy, lantern slide demonstration. A. S. MACMILLAN and D. C. SMITH. The accessory sinuses from the standpoint of the roentgenologist and the clinician. A. S. MACMILLAN. Petrositis from the X-ray standpoint. G. H. POEHRER. Result of the Mosher Toti tear sac operation. M. H. LURIE. Histological slides showing the pathological condition of the internal ear. E. W. HERMAN. Radium and X-ray treatment of cancer of the larynx. H. P. MOSIER. Notes on esophageal cases. F. E. GARLAND. Surgery of the submaxillary gland. C. G. PAGE. Fungi in tracheal and bronchial mucous. G. L. TOBEY, JR. The Tobey Ayer test.

F. E. GARLAND—Harvard Medical School, Bldg. B. Demonstration of historical instruments.

Days to be announced

ISABELLA D. KERR—New England Hospital for Women and Children. The use of avertin anesthesia in tonsillectomies.

MARGARET NOYES KLEINERT—New England Hospital for Women and Children. Mastoidectomies in infants.

L. F. JOHNSON—Massachusetts Memorial Hospital. Bronchoscopic operative clinic.

C. W. BUSH, R. O. PARRIS, and B. N. WEIN—Massachusetts Memorial Hospital. Operations.

H. L. BABCOCK—Massachusetts Memorial Hospital. Otolological problems in contagious diseases.

A. W. ROWE and D. W. DEURY—Massachusetts Memorial Hospital. Endocrine factors in deafness.

OLIVER A. LOTHROP—Newton Hospital. Tonsil, sinus and septum operations, reduction of recent fractures of the maxilla and nasal bones, discussion of the indications for maxilla and sinus surgery.

CHARLES I. JOHNSON, DONALD H. MACDONALD and EDGAR M. HOLMES—Newton Hospital. Operations and demonstration of cases.

SURGERY OF THE EYE

MONDAY

Staff—Massachusetts Eye and Ear Infirmary—2. Operations.

V. G. CASTER—Massachusetts Eye and Ear Infirmary—2. Visual fields in neurological cases.

T. L. TERRY—Massachusetts Eye and Ear Infirmary—2. Pathological demonstration.

J. H. WAITE and associate—New England Deaconess Hospital—2. The eye in diabetes.

W. B. LANCASTER—330 Commonwealth Ave.—2. The Extonometer.

TUESDAY

H. B. C. REIMER and assistant—Massachusetts Eye and Ear Infirmary—9. Operations.

A. J. BENELL—Massachusetts Eye and Ear Infirmary—9. Technique in photographing the fundus.

J. W. WHEELER—Massachusetts Eye and Ear Infirmary—9. Plastic operations.

W. D. ROYLAND—Massachusetts Memorial Hospital—9. Operations.

J. S. FRIEDENWALD—Massachusetts Eye and Ear Infirmary—9. Slit lamp ophthalmoscopy.

PETER MCADAMS—St. Elizabeth's Hospital—11. Operations.

WEDNESDAY

J. H. WAITE and assistant—Massachusetts Eye and Ear Infirmary—9. Operations.

A. J. BENELL—Massachusetts Eye and Ear Infirmary—9. Technique of photographing the fundus.

F. H. VERHOEFF and assistant—Massachusetts Eye and Ear Infirmary—9. Operations and demonstration of cases.

Staff—Carney Hospital—9. Operations.

Staff—Boston Dispensary—9. The eye and syphilis.

HUGH DOWNING—St. Elizabeth's Hospital—11. Operation for cataract.

ALLEN ORENWOOD—Massachusetts Eye and Ear Infirmary—2. Fundus cases.

T. L. TERRY—Massachusetts Eye and Ear Infirmary—2. Contact glasses.

Staff—Massachusetts Eye and Ear Infirmary—2. Motion picture demonstration of operations.

J. J. REIDAN, SOMA WEISS, and DONALD MUNRO—Boston City Hospital—2. The eye in arteriosclerosis.

V. G. CASTER—Long Island Hospital—2. Operative and dry clinic.

THURSDAY

E. K. ELLIS and assistant—Massachusetts Eye and Ear Infirmary—9. Operations.

H. B. C. REIMER—Massachusetts Eye and Ear Infirmary—9. External diseases of the eye.

B. SACHS—Beth Israel Hospital—9. Operative and dry clinic.

C. N. SPRATT and others—Massachusetts Eye and Ear Infirmary—9. Motion pictures of operations.

FRIDAY

W. H. LOWELL and assistant—Massachusetts Eye and Ear Infirmary—9. Operations.

DR. MCCARTHY—Massachusetts Eye and Ear Infirmary—9. Howe Laboratory—9. Color vision testing.

J. J. REIDAN—Boston City Hospital—9. Operations.

V. G. CASTER—Massachusetts Eye and Ear Infirmary—2. Neurological cases, ocular paralysis.

T. L. TERRY—Massachusetts Eye and Ear Infirmary—2. Pathological demonstration.

E. B. DUKERTY—Massachusetts Eye and Ear Infirmary—2. Traumatic cases, operations and results.

J. J. REIDAN and W. B. CASTLE—Boston City Hospital—2. The eye in anemic patients.

SCIENTIFIC EXHIBITS

AT HEADQUARTERS, STATLER HOTEL

- FRACTURES** Demonstrating methods of treating fractures, under the auspices of the New England Fracture Committee of the American College of Surgeons.
- PLASTIC SURGERY** An exhibit of models, photographs, and diagrams, illustrating the different methods employed in plastic surgery and the results.
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- MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH** An exhibit illustrating the activities of this department.
- CANCER** An exhibit from the Palmer Memorial Hospital, Collis P. Huntington Memorial Hospital, and the Providence State Cancer Hospital. Lantern slides, charts, and photographs illustrating cancer of the various organs of the body, the diagnosis and the results obtained by different forms of treatment. Also, an exhibit of specimens of cancer from many parts of the body.
- OPHTHALMOLOGY** Charts and photographs illustrating melanotic sarcoma and other conditions of the eye. Heredity of various reactions. Hereditary blindness pedigree of blindness.
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- HARVARD DENTAL SCHOOL** An exhibit of models, photographs, and diagrams showing the restoration of extensive defects and deformities of the face and jaws by plastic surgery and dental prostheses, including cases of soldiers wounded in the World War.
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- HARVARD MEDICAL SCHOOL, WATKINS MUSEUM** Anatomy anatomical specimens pathology pathological specimens.

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SURGERY, GYNECOLOGY AND OBSTETRICS

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ACUTE RAPIDLY SPREADING INFECTIONS FOLLOWING TRIVIAL INJURIES OF THE HAND¹

SUMNER L. KOCH M.D. F.A.C.S. CHICAGO

IT is particularly appropriate that this group of papers collected in honor of Dr. Allen B. Kanavel and of his many years of service as associate editor of *SURGERY, GYNECOLOGY AND OBSTETRICS* should include a paper upon acute infections of the hand. There are few more beneficent contributions to surgical teaching and practice than his accurate and clear cut demonstration of the surgical anatomy of the hand and of the routes of extension of infection within the hand and forearm. That demonstration and the logical methods of surgical treatment deduced therefrom, with their validity supported by many and carefully controlled clinical observations constitute the basis of his well known monograph, *Infections of the Hand*. Interestingly too the first edition of that monograph appeared practically in serial form in the first volume of what was then an uncertain venture in the field of medical journalism. We would not venture to estimate how many lives have been saved and how many infected hands have been preserved as functioning members as a result of Kanavel's work. We do believe however that his teachings will constitute an enduring commemoration and that they will continue to exert a directing and beneficent influence upon the treatment of infections of the hand when our generation has become but a memory.

No type of infection can develop more rapidly or become a menace to life with more

dramatic and deadly haste than that type of infection variously termed acute lymphangitis, acute spreading cellulitis, acute streptococcic septicæmia and, by the laity, blood poisoning. Although such an infection can be introduced into the body through any break in continuity of skin or mucous membrane in our experience it has followed most often a trivial injury of a finger or hand, an infection of the lip or face which has begun as an apparently innocent furuncle or the extraction of an infected tooth. Of these the acute spreading infections which have followed an injury of the upper extremity have been the most common.²

In the series of cases reported in this paper the mortality has been almost one third, but the patients who have survived, and this is the lesson which Kanavel has stressed so often

My first personal contact with such a case made an indelible impression upon my mind, and I have often referred to it since. Nine years ago a junior medical student on his service at the Lying in Dispensary infected a scratch wound on the dorsum of the right index finger. The finger became somewhat swollen and painful and he persuaded one of the surgeons in the out-patient department to incise it under a local anæsthetic. No pus was found. The following day the finger was more swollen and painful; there were a few red lines extending upward along the forearm and the patient was obviously ill. When first I saw him on that day he was told he must go to bed, take as much fluid as possible, put a hot water wet sterile dressing over the entire upper extremity, and that under no circumstances must any one be allowed to use the finger. He rather protested against this advice because he still thought there was pus in the finger; but since he assured me that he would carry out the treatment faithfully at home and that it would be very inconvenient for him to enter the hospital he was allowed to go. I heard nothing more from him and had completely forgotten the matter when, a week later, I saw a notice on the bulletin board that the members of the junior class were excused for the afternoon to attend the funeral of this young man. He had gone home from the hospital, persuaded a doctor in his neighborhood to incise the finger and within 24 hours had developed a severe chill, a temperature of 104 degrees, and all the signs of a malignant generalized infection. Within 48 hours symptoms of a diffuse pulmonary involvement appeared and within another 48 hours he had succumbed to the infection.

¹From the Department of Surgery, Northwestern University Medical School. Read in part before the Hartford Medical Society, Hartford, Connecticut, April 24, 1934, and the Aux Plaines Branch of the Chicago Medical Society, Oak Park, Illinois, April 27, 1934.

during the past 30 years have been those who were treated by conservative measures, and in whom active surgical intervention was delayed until there was no question as to the presence of a definitely localized suppurative process.

The cases of acute rapidly spreading infection following trivial injuries of the hand which have come under our observation resolve themselves into 4 definite groups (1) Those in which the infection gradually subsided and eventually cleared up without local destruction of tissue or abscess formation. (2) Those in which the original injury healed rather rapidly and in which the inflammatory reaction in the hand and forearm disappeared soon after but in which the axillary lymph glands broke down with resulting abscess formation sometimes underneath the pectoral muscles. (3) Those in which the infection and the accompanying inflammatory reaction advanced rather rapidly for a time then came to a standstill and then gradually receded. As the inflammation receded, localization and abscess formation developed frequently with extensive destruction of tissue. (4) Those in which the infection advanced rapidly and continued in spite of every effort to check it to a fatal termination.

In order to make this presentation as definite and clear cut as possible the cases reported are presented in accordance with this classification rather than in a chronological order.

GROUP I RECOVERY WITHOUT LOCALIZATION OF INFECTION OR ABSCESS FORMATION

CASE 1 B. A. Passavant Memorial Hospital, 4005 March 4-10, 1915

This patient, a physician of 28 years, the day before admission to the hospital struck the dorsum of his left thumb with the end of a glass tube while transferring a culture of a hemolytic streptococcus. There was no bleeding at the site of injury and he paid no attention to the matter until the following morning, when he noticed redness at the site of the puncture and swelling over the metacarpophalangeal joint. At 6:00 a.m. the swelling had extended to the wrist. At noon there was a row of small painful beads one half the size of a split pea extending upward along the volar surface of the forearm. At 3:00 p.m. there were three red lines extending from the wrist to the axilla.

On admission to the hospital at 4:00 p.m. his

temperature was 99.4 degrees, his pulse 120, his leucocyte count 11,800. About the small puncture wound on the dorsum of the metacarpal of the thumb was an area of redness and swelling about as inch in diameter. The red streaks mentioned extended upward along the lateral and anterior aspect of the forearm, and the medial aspect of the arm.

A large warm wet dressing was applied to the entire left upper extremity and heat maintained over it. The following day the temperature which had risen to 100.4 degrees the evening of his admission to the hospital, dropped to normal and the red streaks of lymphangitis had disappeared.

March 7 his temperature again arose to 100.2 degree and he complained of a sore throat. Cultures were made from the secretion of both the nose and throat and subsequently showed both hemolytic and non hemolytic staphylococci in the nasal secretion and many long chained streptococci in the pharyngeal secretion. When the patient was dismissed from the hospital March 10 he felt well the signs of inflammation had disappeared from the left upper extremity and his temperature had not risen above normal for 48 hours.

CASE 2 R. K. Rockford Hospital, Rockford, Illinois September 9-14, 1928

This patient a physician of 43 years, sustained an abrasion of the left index finger about September 1 but paid no particular attention to it at the time. Saturday afternoon September 8 he operated upon a patient with a Bartholinian abscess. The same evening he noticed that the finger was inflamed and painful. He felt restless and irritable, and finally went to his office and picked at the finger with a scalpel. All that night the finger and hand throbbed and ached, he was restless and slept very little. Early Sunday morning he called a colleague, who infiltrated the finger thoroughly with procaine, induced it and stated he was certain there was no pus there for he focused all the tissues down to the bone.

When I saw the patient Monday evening, September 10, he was obviously very ill. Perspiration was standing in beads on his face and neck. His temperature was 103 degrees, he had had several severe chills. There was a thin serous discharge from an incision 4 1/2 inch in length on the palmar surface of the right index finger. Red streaks extended up the forearm and arm, converging toward the axilla. Fortunately no further surgical treatment had been carried out, and at the suggestion of a former student of Dr. Karmel who had seen the patient Monday morning, a massive warm wet dressing had been applied to the entire upper extremity throughout Monday.

This treatment was continued, fluids were administered by mouth and by rectum, and the patient made a gradual and uneventful recovery without definite localization of the infection or abscess formation.

In order to avoid needless repetition, we have included only the above 2 cases of this

group. We have observed 19 other cases with practically an identical story—a slight injury, rapidly developing symptoms of an acute infection, early lymphatic involvement with red streaks extending up the forearm, and in some cases to the axilla, gradual subsidence under conservative treatment of both local and general symptoms and eventual recovery without localization or abscess formation, in a period varying from 2 to 10 days.

The course of events in such cases emphasizes the fact that an acute spreading infection can be arrested rather rapidly and without localization or abscess formation if the infection is not of overwhelming virulence if the resistance of the patient is adequate and if proper measures to combat the infection are instituted promptly. Such cases give us a certain degree of assurance in that they demonstrate the fact that not every acute rapidly spreading infection is necessarily followed by disastrous results even though the danger signals—the red lines of lymphatic extension—are present when the patient is first seen.¹

It is of some interest in connection with this group of cases that none of them under our care received antistreptococcal serum. We have not at any time seen definite indications that it has been of value. It should also be said in fairness that we have not observed any harmful effects in patients to whom serum has been given by others.

GROUP 2. RAPID HEALING OF THE ORIGINAL INJURY AND DISAPPEARANCE OF THE SYMPTOMS OF RAPIDLY SPREADING LYMPHANGITIS, LATER ABSCESS FORMATION IN OR ABOUT THE AXILLA SUPRACLAVICULAR OR SUBPECTORAL REGION

CASE 3. E. P. 140033 Wesley Memorial Hospital August 21–September 6 1928

This patient, a girl of 3½ years, on Friday August 17 fell from a small wagon to the sidewalk and struck her left elbow² just breaking the overlying skin.

Karnel has suggested that only 1 per cent of cases which begin as an acute lymphangitis go on to localization and abscess formation. That doubtless is a fairly accurate estimate for the majority of these cases are doubtless seen in the routine of daily practice, and do not come to the hospital or to the attention of the man who confines his work to surgical practice.

This case is 1 of 8 included in the series in which the initial injury was not upon the hand. It is included because the course of events is so definitely similar to that in the remaining cases, and because of the interesting complicating infection in the lower extremity.

Her mother painted mercurochrome solution over the elbow. The patient felt well until Sunday at 5:30 p.m. when she humped her elbow and complained of pain. Her father noticed a superficial abrasion the size of a dime covered with pus. He wiped it off with a swab saturated with mercurochrome and covered it with gauze. That night, about 1:00 a.m. the patient awoke screaming and trembling, her eyes were staring, and she seemed entirely unconscious of her surroundings for about 15 minutes. At 7:00 a.m. she had a second convulsion.

During most of Monday she was apparently quite normal but shortly after midnight Monday she had a third convulsion and during the remainder of the night she had repeated convulsions though not as severe as the first 3.

She was admitted to the hospital at 9:30 Tuesday morning with a temperature of 103.6 degrees, a pulse of 120. Just above the left elbow was a small elliptical denuded area 1 by 2 centimeters. The arm from elbow to shoulder was swollen and inflamed. The swelling involved the entire axillary region; the axillary lymph glands were palpable and tender. The leucocyte count was 17,900; the erythrocyte count 4,220,000. A massive warm wet dressing was applied immediately to the entire left upper extremity and 1500 units of tetanus antitoxin injected subcutaneously in the right thigh.

Between August 21 and 23 the patient's temperature fluctuated between 100.5 and 104.8 degrees, the pulse between 100 and 160. In spite of the continuous application of large warm wet dressings there was little change in the appearance of the arm and the patient constantly seemed very ill and very toxic.

August 25 an area of red mottled discoloration was noted over the medial aspect of the right thigh, and within 24 hours this discoloration had spread and involved the lateral, posterior and medial aspects of the thigh from hip to knee. Massive warm wet dressings were applied over the entire area but the swelling and inflammation continued to extend and by August 27 had involved the vulva and perineum. On that day the swelling of the thigh gave a feeling of fluctuation and it was thought liquefaction was taking place. Then rather rapidly the inflammatory reaction began to subside, and by August 31 it had practically disappeared from the lower extremity.

In the meantime the inflammatory reaction had also disappeared from the greater part of the left upper extremity and a definite localized fluctuating mass developed in the left axilla. This was incised September 1 with as little trauma as possible and about 30 cubic centimeters of thin pus evacuated. Cultures of this pus subsequently showed a pure growth of a non-haemolytic, short chained streptococcus.

Recovery took place very rapidly, after incision of the axillary abscess the temperature which had fallen to 98.8 degrees August 31 the day before incision rose to 100.6 degrees September 1 and there

after did not rise above normal. The patient was dismissed from the hospital September 6 with the drainage wound almost healed.

CASE 4 H. R. Garfield Park Hospital, 39471 December 29, 1931-January 18, 1932

This patient, a man of 36 years, sustained a scratch wound of the dorsal surface of the third right metacarpophalangeal joint 12 days before admission to the hospital. The affected hand became painful and swollen, then opened spontaneously and discharged a little pus. The symptoms apparently subsided only to flare up again a few days later and with the recurrence of inflammation the patient began to have chills, fever and sweats.

He was admitted to the hospital on the service of Drs. Hatus December 29 with a temperature of 101.4 degrees and pulse of 110. When I first saw him the same day the wound on the dorsum of the hand had practically healed and the only abnormal finding in the hand and forearm was a slight swelling and edema as compared with the opposite side. In the axilla, however, and extending down the medial side of the arm was a deeply situated firm mass over which the skin was tense, reddened, and edematous.

A massive warm wet sterile dressing was applied over the arm and axilla and the patient urged to take as much fluid as possible. Blood was taken for culture and was later (January 3) reported as showing a rather scanty growth of *Staphylococcus albus*. Blood examination December 31 showed 5,000,000 red cells and 15,800 white cells.

January 4 the patient was given a direct blood transfusion of 300 cubic centimeters.

During a period of 11 days, from December 29 to January 8 the patient's temperature ranged between 98.8 and 103.2 degrees, his pulse between 88 and 123. The warm wet dressings were kept almost constantly over the affected area and the fluid intake maintained at a maximum. The leucocyte count had increased from 13,800 December 31 to 14,000 January 4 and to 18,600 January 8. At the same time the axillary mass had become a little larger, less indurated, and the overlying skin could no longer be moved apart from the underlying mass.

On the afternoon of January 12 the patient's temperature rose to 103.4 degrees, the highest level that it reached at any time. The following morning under nitrous oxide anesthesia the axillary abscess was opened by an incision over the most dependent portion of the fluctuating area, and a considerable amount of thin green pus evacuated, most of it from a definite cavity underneath the pectoralis major muscle. Culture of this pus was reported 3 days later as "practically pure culture of colon bacillus, a few staphylococci present."

The patient's temperature fell to normal the following day and only twice subsequently rose above normal, once to 100 degrees, once to 100.6 degrees. When he left the hospital January 18 the wound discharge had almost ceased.

CASE 5 R. K. Passavant Memorial Hospital 17196. March 7-April 6, 1934

This patient, a cooper of 33 years, a week before admission to the hospital sustained three superficial wounds of his left thumb from the flanged head of a tool which accidentally slipped from his hand as he was driving it against a barrel hoop. Little attention was paid to the wounds at the time. A week later he noticed pain and soreness in the left axilla but he continued work for another 5 days, at the end of which he reported to the company physician with fever, headache, pain in the left upper extremity and exquisite tenderness in the left axilla.

On admission to the hospital 5 days later the patient's temperature was 101.6 degrees, his pulse 100, his leucocyte count 15,700. The original injuries over the left thumb had almost healed but the left axillary region was red, indurated, and tender. The most striking symptom, however, was a diffuse, fiery red, maculopapular eruption which covered his entire body and actually gave him the appearance of a boiled lobster.

For 6 days the patient appeared very ill and toxic in spite of continued application of large warm wet dressings to the entire left upper extremity and forced administration of fluids. During this time his temperature fluctuated between 99.5 and 102.8 degrees, his leucocyte count between 15,000 and 20,000. On March 13 the seventh day after admission, his temperature reached normal for the first time and the erythema was very much diminished. During the next few days desquamation went on rather rapidly and the skin could be peeled from his trunk and extremities in large dry patches (Fig. 1). At the same time the axillary induration became less marked and less extensive.

March 31, a small well demarcated axillary abscess which had become quite superficial was incised and evacuated. Cultures of the pus showed only a non-hemolytic *Staphylococcus aureus* although the symptoms of the infection throughout its course were clearly those of a virulent streptococcus closely allied to the streptococcus of scarlet fever.

CASE 6 R. J. Passavant Memorial Hospital, 4280 October 21, 1930-April 21, 1931

This patient, an undertaker of 38 years, while embalming a body Saturday evening October 18 sustained a scratch wound of the dorsum of the proximal phalanx of the right middle finger. He paid no attention to it until Monday morning when he noticed a little pus draining from the hand at the site of injury. Monday afternoon he had a violent chill and ached all over his body. Pain and tenderness, which during the day had begun to involve the hand, by evening had reached the shoulder. His temperature Monday evening was 104 degrees. A doctor who was called applied antiphiogistine to the hand and forearm.

When I first saw him on Tuesday evening at 6 o'clock he was acutely ill, perspiring profusely and almost in a state of collapse. His temperature was 104 degrees, his pulse 108. His right hand, forearm, and arm were painful to touch, hot and somewhat swollen though less, he stated, than the day before.

Pain had become fairly well localized to the medial side of the arm and to the shoulder. The axillary and supraclavicular glands were enlarged and very tender. Red streaks which he had noticed Monday on the medial aspect of the arm had disappeared. He was admitted to the hospital immediately, a massive warm wet dressing applied to the entire upper extremity and administration of fluids begun.

During the first week in the hospital his temperature fluctuated between 101.4 and 99.4 degrees though after the evening of admission it did not rise above 103 degrees. The symptoms of infection in the hand and forearm cleared up within a few days but the evidence of deep seated inflammation in the axilla and supraclavicular region became constantly more definite. Eight days after his admission to the hospital it was thought that a definite localization of pus had taken place over the medial wall of the axilla. Under nitrous oxide anesthesia an incision was made through the thick oedematous subcutaneous tissue and at a depth of $\frac{1}{2}$ inch thin pus was found. Cultures of this pus subsequently showed a pure growth of a long chained hemolytic streptococcus.

Following drainage of the axillary abscess the temperature level dropped about a degree, ranging between 102.4 and 99 degrees during the second week. During the third week the level was still lower between 101.4 degrees and normal though it rose consistently each afternoon to a level of 101 degrees or higher. During the fourth week (November 11-17) the temperature level gradually rose again to a range between 103.4 and 100 degrees, and with the rise of temperature there developed a widespread inflammation and induration of the entire dorsal surface of the trunk beginning above over the lower cervical vertebrae and gradually extending downward. November 17 there was noted a painful swelling over the left ninth, tenth and eleventh ribs and red streaks running downward and forward toward the left groin. With widespread application of warm wet dressings the inflammation gradually became less marked and by November 24, the end of the fifth week, the temperature had reached a normal level.

During the sixth week the temperature again began to rise and as it did so signs of an abscess just inferior to the medial end of the right clavicle appeared. This was opened at noon, December 3, and the area of fluctuation found filled with hemolyzed blood. This material when cultured also showed a pure growth of a long chained hemolytic streptococcus. Because of a persistent tendency toward oozing after incision the incised area was packed rather tightly with gauze, but it continued to bleed throughout the course of the afternoon and evening. At ten in the evening the patient was again taken to the operating room, a small bleeding vessel in the wall of the cavity ligated and pressure maintained over the incised area until every evidence of oozing had disappeared. Two days later because his red cell count had dropped to 4,200,000 and his hemo-

globin to 75 per cent he was given a transfusion of 450 cubic centimeters of citrated blood.

Following transfusion the patient's condition improved very definitely and the temperature dropped to a level of 99.4 to 98.2 degrees only to rise again by December 17 to 100.6 degrees as a definite swelling began to appear over the anterior aspect of the sternum. A few days later this swelling disappeared as the accumulated pus ruptured into the area previously drained by the infraclavicular incision, and the temperature again receded. Such a train of events occurred five times subsequently with localization of infection in a pocket posterior to the original axillary abscess January 15 lower down on the chest wall January 30 over the medial end of the clavicle February 22 over the anterior aspect of the right shoulder March 4 and in the middle portion of the supraclavicular region March 24. As each localized area was drained (two accumulations were allowed to rupture spontaneously) the patient's temperature receded and his general condition improved.

He was dismissed from the hospital April 21 exactly 6 months after his admission, with all the drainage wounds healed and after his temperature had remained normal for 17 days.

CASE 7 F. C. Passavant Memorial Hospital
7728 September 4-October 1 1931

This patient, an engineer of 35 years on Monday August 24 sustained a cut of the left thenar eminence from broken porcelain. He went to a physician immediately who cleaned the wound and sutured it. Within 24 hours the thenar area was red and tender and red streaks appeared extending upward over the volar surface of the forearm. The sutures were immediately removed from the wound and some thin bloody discharge was evacuated. A dressing saturated with mercurchrome solution was applied.

When I first saw the patient 7 days after the injury he was in bed at his home and looked ill. His temperature was 102 degrees. The swelling about the site of injury had diminished and there was little discharge from the open wound. The forearm and arm showed no evidence of active inflammation, but in the axilla underneath markedly indurated skin and subcutaneous tissue was a firm tender mass about the size of a baseball. The patient who had been going to the doctor's office each day for dressings, was put to bed and a large warm wet dressing was applied over the entire axillary area. September 4, 11 days after the injury he was admitted to the hospital. On admission his temperature was 100.8 degrees, his pulse 88, his leucocyte count 10,600. The axillary mass had become a little larger, the skin over it had become red and inflamed and there was a definite sense of fluctuation over its central portion.

The following morning under ethylene anesthesia the abscess was opened and a considerable amount of thick green pus was evacuated. Cultures of this pus after 48 hours showed a pure growth of a non-hemolytic streptococcus. Twenty four hours after operation the patient's temperature had dropped to

normal and remained normal for 36 hours. September 7: 2 days after incision of the axillary abscess, it was evident that some pus had accumulated at the site of the injury in the palm. This was opened through a small incision in the line of the original injury. Shortly afterward the patient's temperature began to rise and in 24 hours had reached 103.2 degrees. At the same time redness and tenderness appeared over the line of the brachial vessels over the medial aspect of the arm. For 48 hours the patient's temperature fluctuated between 98 and 103.2 degrees and he felt and looked very ill. At the end of that period the temperature receded, and September 11 again reached normal and remained at a level of 98 to 99 degrees for 6 days. During this time the inflammatory reaction disappeared entirely from the hand and almost completely from the axilla, but the redness and inflammatory reaction over the medial aspect of the upper arm continued in spite of the permanent application of warm moist dressings. September 17 the temperature began to rise again and as it did so evidence of subcutaneous abscess formation appeared over the middle of the arm in the line of the brachial vessels. September 20 the skin at this site broke down and thick yellow pus was discharged from the opening. September 22 under ethylene anesthesia the infected area was opened more widely. The same afternoon the temperature, which had remained at a level of 100 to 102.4 degrees for 4 days, again dropped to normal, and remained normal until the patient was dismissed from the hospital 6 days later. At this time there was only a small amount of thin seropurulent discharge from the open wound on the medial aspect of the arm, but some destruction of skin and subcutaneous tissue had taken place and at the edge of the denuded area the skin was undermined and indurated. The long and narrow open wound showed little tendency to heal and it was more than 2 months after the patient left the hospital before the raw surface was completely covered with epithelium and healing complete.

This group of 5 cases includes 2 of the most difficult cases, with the exception of the fatal cases, in the entire series and the case (No. 6) in which the question of recovery or of a fatal outcome remained for the longest time in doubt.

One important element in the seriousness of these cases lies in the fact that the infection has broken down the main line of defense—the axillary lymph glands, and if by any mischance in incising an abscess one breaks through the limiting wall of leucocytes and fibroblasts the liberated infectious material finds ready access into the open lymphatics that lead directly into the systemic circulation.

The group as a whole helps to emphasize again the fact so often stressed by others, that simply incising an abscess due to a hemolytic streptococcal infection can cause a recrudescence of symptoms and a severe generalized reaction and that it is the part of wisdom to limit one's surgical procedures to the very minimum—a simple incision without retraction without stretching of the wound edges and without digital exploration of the abscess cavity. In Case 6 we finally permitted the abscesses to rupture spontaneously and felt that in so doing we were giving the patient the greatest measure of safety.

GROUP 3. RECOVERY WITH LATE ABSCESS FORMATION

CASE 8. C. H. St. Luke's Hospital #5935
June 2-18, 1930

This patient, a physician of 51 years sustained an injury of the volar surface of the distal phalanx of the right index finger Saturday May 31, 1930. Just after exploring an empyema cavity with the right index finger he turned toward the instrument table and struck the gloved finger tip covered with pus, against a sterile hypodermic needle attached to a syringe projecting over the side of the instrument table. He continued with the operation and paid no further attention to the injury. The next day the finger became painful and tender to the touch and he was conscious of throbbing pain when he held the hand in a dependent position.

I saw him first Monday morning, 42 hours after the injury. The distal phalanx was moderately swollen, and very sensitive to light touch but it was not tense as is the distal phalanx with the typical infection of the anterior closed space. At the center of the volar surface could be seen a tiny discolored point at the site of the puncture wound.

I urged him to enter the hospital immediately and have a large warm wet dressing applied to the entire upper extremity. By the time he reached the hospital approximately 2 hours later red streaks had appeared on the volar surface of the forearm and extended upward to the elbow. At that time his temperature was 98.6 degrees, his pulse 88, his leucocytes count 15,500.

A large warm wet sterile dressing was immediately applied to the entire extremity, an electric baker placed over it, and administration of fluids begun. During the next 4 days the swelling of the finger gradually increased, and slowly extended to the hand. The patient's temperature fluctuated between 99 and 101.8 degrees but for the most part remained close to 101 degrees (Fig. 2). The leucocyte count also fluctuated from day to day (Fig. 3). As the infection extended upward (Fig. 4) the symptoms of toxic absorption became more pronounced and the patient complained of persistent and intense

pain of such a degree that hypodermics of $\frac{1}{4}$ grain of morphine gave relief only for a hour. At times he would become irrational and think that he was at work in the operating room.

June 6 4 days after admission to the hospital it was evident that the index finger was definitely enlarged as compared with the others. It was held in semiflexion but no especial tenderness could be elicited by gentle pressure over the tendon sheath. The epitrochlear and axillary glands had become definitely enlarged. A culture of the pus recovered from the empyema cavity was reported as showing a pure growth of a hemolytic streptococcus.

The following day June 7 the swelling of the entire index finger was definitely and markedly increased. Under nitrous oxide anesthesia the finger was opened by a lateral (radial) incision extending from the middle of the distal phalanx to the level of the metacarpophalangeal joint. Thin milky pus filled both the subcutaneous tissues and the tendon sheath. In other words, the infectious process involved not only the tendon sheath but all the tissues of the finger including the soft tissues of the distal phalanx. Since gentle pressure over the thenar space caused an escape of pus from the proximal end of the incision in the finger the thenar space was opened through an incision on the dorsal surface of the hand at the radial side of the second metacarpal bone. Cultures of the pus subsequently showed a heavy growth of *Streptococcus hemolyticus* and a scant growth of *Bacillus pyocyaneus*.

Following incision and drainage the patient's condition gradually improved. Two days after operation a dusky red area of gangrene of the subcutaneous tissues at each side of the incision over the distal half of the finger became apparent and eventually went on to a considerable loss of subcutaneous tissue.

The hand was dressed daily with every care to maintain asepsis so as to preserve it possible the flexor tendons. They were still intact but exposed to the depth of the wound when the patient left the hospital June 18. The same careful treatment with dressings saturated with Dakin's solution, was continued at the patient's home but in spite of it the tendons became necrotic and the digital portions of the flexor tendons had to be removed from the finger. Healing of the finger was complete August 13 2½ months after the original injury.

CASE 9 C D Cook County Hospital 1277486
March 18-April 2 1933

This patient a laborer of 41 years 2 days before admission to the hospital stuck himself with a needle over the middle of the palmar surface of the middle phalanx of the right index finger. The next day because of pain and swelling he scraped it with a razor blade. Twenty-four hours later he was admitted to the hospital with a temperature of 103 degrees and a pulse of 112. The entire right hand and forearm were swollen and inflamed red streaks were present along the medial side of the arm. The epitrochlear glands were enlarged and tender.

Immediately after admission a massive warm wet dressing was applied to the entire right upper extremity and continuous heat applied over it. With continued warm wet dressings complete bed rest, and a forced fluid intake the symptoms of infection gradually subsided. March 25 1 week after admission to the hospital a large blister which had formed over the palm between the base of the index finger and thumb ruptured spontaneously and about an ounce of thin yellow pus was discharged. Thereafter the patient's temperature receded to normal and he was dismissed from the hospital April 2 with a slight seropurulent discharge still present from the palmar wound at the base of the index finger.

Subsequently April 27, because the wound discharge continued and the index finger remained stiff in extension he was readmitted to the hospital. The incision made along the radial side of the index finger reopened and the soft edematous and semi necrotic flexor tendons removed from within the tendon sheath. Healing followed without further complications.

CASE 10 M E Nurses Infirmary Cook County School of Nursing December 3 1932-January 24 1933 February 28-March 16 1933

This patient, a nurse of 30 years, reported to Dr Paul Rhoads on the morning of December 3 with swelling and throbbing pain in the left thumb and hand. The day before she first noticed slight pain in the left thumb, during the night the pain became intense and throbbing and by morning there was definite swelling involving the thumb and thenar area. She could recall no definite injury involving the thumb.

On admission to the hospital her temperature was 100.3 degrees her pulse 98. The palmar surface of the left thumb and thenar eminence was swollen red and tender. The patient was put to bed a large warm wet dressing was applied to the left upper extremity and fluid given in maximum amounts. During the next 7 days her temperature ranged between 98 and 102 degrees her pulse between 80 and 120. The area of inflammation and swelling gradually extended upward (Fig. 5) and was more pronounced on the radial side of the hand and forearm. December 11 and 12 particularly she complained of tension and drawing in the hand and forearm she said it felt as though the hand would burst. Any movement of the thumb or wrist caused exquisite pain. December 14 the patient seemed better the hand and forearm were less painful and movement of the thumb caused less pain. December 15 a small area of localized redness and fluctuation began to appear at about the center of the radial half and lower half of the volar surface of the forearm. The following day this area of redness and fluctuation was more definite and more extensive.

On the afternoon of December 16, under nitrous oxide anesthesia an incision was made on the radial side of the forearm just volar to the subcutaneous border of the radius. When the fascial attachment of the flexor carpi radialis was divided the radial

bursa could be seen bulging into the wound. When it was opened about 4 or 5 ounces of green pus were evacuated from both the radial bursa and the common flexor sheath. The sheath of the long flexor tendon of the thumb was then opened in the palm and the same type of green pus found. The flexor tendon of the thumb was bright and shining.

Cultures of the pus from both forearm and hand subsequently showed a pure growth of a hemolytic streptococcus.

Thereafter improvement was definite and progressive but complicated by the development of two other conditions.

December 24 the patient was up out of bed for 15 minutes for the first time. December 25 at 3:30 a. m. she suddenly felt a sharp vise-like pain in the left arm, shoulder and left side of the chest, including the cardiac area. Associated with it she had difficulty in breathing. The duration of the attack was about a half hour. There was no cough or expectoration associated with it but a slight rise in temperature to 99.6 degrees, and an increase in pulse rate to 120. Physical findings were entirely normal. She had never had a similar attack before.

December 26 she complained of pain in the left lower chest and lumbar region, a pain different from that present the day before and similar to pain she had experienced on previous occasions. Throughout the next day she complained of persistent pain on attempting to void and at 9:00 p. m. passed some blood clots and urinary gravel.

January 1 she had an attack of nausea and vertigo associated with a subnormal temperature, a cold clammy skin and a rapid irregular pulse. This attack lasted about 3 hours. January 4 she had another attack of pain in the left kidney region. Thereafter she gradually gained in appetite and strength and was discharged from the infirmary January 24 with the drainage incisions in the hand and forearm almost healed.

February 25 she was readmitted to the Nurses' Infirmary complaining of severe pain over the precordium, tachycardia and palpitation, shortness of breath and daily fever from 99 to 99.6 degrees. She stated that following the initial attack of anginal pain December 25 she had not had any similar severe pains until the preceding day but that she had had a constant slight pain in the chest, and tachycardia and palpitation on the slightest exertion. At 8:00 p. m. the day before admission she was suddenly seized with a vise-like pain over the center of the chest which radiated across the precordium and down the left arm to the wrist. This continued for several minutes and was accompanied by marked dyspnea and a feeling of fear that she could not breathe again. After a few moments the sharp pain disappeared, but was followed by less intense pain which persisted. These symptoms, with a slight daily rise in temperature, persisted during the 16 days of the patient's stay in the hospital. At the end of that time she was ordered to return to her home for a prolonged period of rest.

CASE 11. M. P. Passavant Memorial Hospital, 1619 1/2 December 7 30 1935.

This patient, a woman of 59 years, sustained a slight penetrating wound from a chicken bone over the volar surface of the interphalangeal joint of the right thumb Sunday morning, December 3. The wound bled freely; it was only washed with water at this time. The same afternoon the patient began to have pain, which increased in intensity and became throbbing by evening. During the night she slept very poorly and had several chills. Monday morning her temperature was 102 degrees. Swelling of the thumb, which had begun Sunday evening, had extended to the hand. On the advice of a physician bot. antipain was applied to the hand, but without helpful effect.

Tuesday, December 5, the swelling began to extend up the forearm and red streaks appeared extending as far as the elbow. About 2:00 a. m. Wednesday morning, because of the intense pain, her physician inserted a needle into the soft tissues just proximal to the web between the index and middle fingers and between the middle and ring fingers, and attempted unsuccessfully to aspirate pus.

On Thursday morning, December 7, when I first saw her she was irrational and moaning with pain. Her face was hot and flushed, her temperature 102 degrees, her pulse 100. The entire hand and forearm were tense, inflamed, and swollen. Red lists of lymphatic involvement extended upward along the medial surface of the arm.

She was admitted to the hospital at 11:00 a. m., a massive warm wet sterile dressing immediately applied to the entire upper extremity and an electric heater placed over the whole upper extremity. On admission her temperature was 101 degrees, her pulse 100, her leucocyte count 13,250. During the first 24 hours in the hospital she received 5140 cubic centimeters of fluid orally and by proctoclysis, and at 10:00 during her stay of 24 days did the fluid intake fall below 2900 cubic centimeters during a 24 hour period.

The evening after her admission to the hospital, December 8, her temperature dropped to normal and although the swelling and tension in the upper extremity gradually receded, severe pain, particularly at night, remained a distressing symptom and necessitated the use of codeine and aspirin in order to secure rest.

December 11 the continuous warm wet dressing was discontinued and instead the hand was soaked twice daily for 15 minutes in a warm sterile bath, and after each soaking dried out under the electric heater. During the next 10 days the patient's condition gradually improved, her temperature remained at or below normal the greater part of the time and only on two afternoons rose above 99 degrees, once to 99.6 degrees, once to 99.4 degrees. The swelling of the hand and forearm, however, did not completely disappear. It seemed to change from time to time and not to recede steadily.

December 21 the lower part of the forearm just above the wrist was definitely more swollen and painful than it had been. The afternoon temperature had been 99 degrees the day before rose to 100.6 degrees. The white cell count which on 4 examinations had fluctuated between 11,750 and 14,800 rose to 18,000. December 22, the swelling and redness above the wrist were still more marked. The following morning under nitrous oxide anesthesia and through a bloodless field, the radial bursa was opened through a lateral incision just volar to the lower end of the radius. Thick green pus in considerable amount was evacuated from the radial bursa and the retroflexor space above the wrist (Fig. 6). A second incision was made over the sheath of the flexor longus pollicis in the palm and a small amount of similar pus was released. Culture of the pus subsequently showed a heavy growth of *Streptococcus viridans* in pure culture.

Recovery thereafter was rapid and uneventful. The temperature dropped to normal at noon December 24 and only once thereafter was recorded as above normal. The white cell count dropped from 18,000 to 8,750 on December 24. The continuous warm wet dressings, which had been reapplied December 22 were discontinued December 27 and the patient dismissed from the hospital December 30 with the operative wounds healing and with very little wound secretion. She returned to the hospital for dressings every second day for a few times and subsequently at longer intervals until the operative incisions were completely healed January 15, 1934.

Throughout her stay in the hospital every effort was made to maintain the function of the hand by keeping it in the position of function while it was enveloped in a massive wet dressing and by keeping up movement of the fingers and wrist during the free intervals after the continuous wet dressing was discontinued. When she left the hospital she could close the fingers into the palm fairly well, and bring the tip of each finger to the thumb. The range of movement February 21 2 months after operation is shown in Figure 7.

CASE 12 S. J. Cook County Hospital 1417343 February 27-March 24, 1934.

This patient a colored man of 20 years, sustained two small deep knife wounds of the right palm and a number of lacerations of the forehead and face Saturday night February 24. He was admitted to the hospital shortly afterward, and the wounds cleaned and sutured he was dismissed from the hospital the following day Tuesday evening February 27. He was readmitted to the hospital because of pain swelling and evidence of spreading infection in the right hand and forearm. The sutures were immediately removed from the hand and a warm wet dressing applied to the entire right upper extremity.

When I first saw him 2 days later with Dr. Earle Greene the patient was obviously very ill. The entire hand and forearm were swollen tense and hot. Although his skin was very black two dusky red



Fig. 1. Case 5. Extensive desquamation following a generalized, maculopapular erythematous eruption subsequent to a slight injury of the left thumb (a) and a severe spreading infection.

hands of lymphatic involvement could be clearly seen extending upward along the volar aspect of the forearm and the medial aspect of the arm as high as the axilla. The treatment which had been instituted on his readmission to the hospital was faithfully continued, and fluids given in maximum amounts. March 9 evidence of a localizing infection on the radial side of the lower half of the forearm began to appear. Conservative treatment, however was continued until March 13 when it was quite certain that a definite abscess had developed. This was opened under nitrous oxide anesthesia by an incision along the radial side of the forearm just volar to the subcutaneous surface of the radius, and by a second incision through the palmar skin and fascia at the site of the larger original wound a half inch to the radial side of the midline of the palm and one inch distal to the wrist joint. Thick gray pus was evacuated from the abscess in the retroflexor space, which extended ulnarward to the midvertical line of the forearm and upward $2\frac{1}{4}$ inches from the wrist and, through the second incision from underneath the palmar fascia. (It was obviously from infection introduced underneath the palmar fascia through the wound distal to the wrist joint that the acute spreading infection had developed.)

Cultures made from the pus subsequently showed a pure growth of a hemolytic streptococcus.

Following incision and drainage healing took place rather rapidly. By continually urging the patient to keep his hand in a position of supination and by beginning movement of the fingers soon after incision of the abscess a fair degree of mobilization of the fingers and wrist had been attained when the patient was dismissed from the hospital March 24 with the drainage wounds granulating and with little wound discharge remaining. The function of the fingers and hand May 1 $3\frac{1}{2}$ months after the initial injury is shown in Figure 8.

CASE 13 A. R. Passavant Memorial Hospital 16053 November 25-December 9 1933

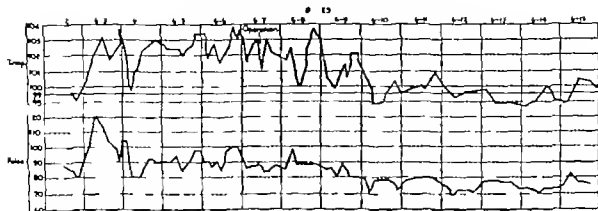


Fig. 5. Case 8. Temperature and pulse curve of patient with paronychia of index finger following puncture wound of distal phalanx.

This patient, a housewife of 40 years, on Saturday November 4, while cutting carrots sustained a cut, so slight that it did not bleed, on the volar surface of the right thumb at the level of the interphalangeal joint. On the following Monday or Tuesday it became painful. She applied iodine to the thumb and began soaking the hand in hot boracic solution. The swelling increased rapidly involving particularly the thumb and thenar area; the index and middle fingers also became stiff and painful.

Saturday a week after the initial injury she first consulted a physician, who advised hospitalization. She was admitted to the South Haven (Michigan) Hospital the same day, and 2 days later the volar and dorsal surfaces of the thumb were incised under ether anesthesia.

Two weeks later November 25, she was admitted to Passavant Memorial Hospital where I saw her for the first time. On admission her temperature was 100 degrees, her pulse 124, her leukocyte count 22,500. The urine was heavy with albumin and casts, and contained from 3 to 8 red blood cells and from 50 to 60 pus cells in each high power field.

The hand and forearm were markedly swollen and inflamed (Fig. 6). Thick pus was draining profusely from the incision over the volar surface of the thenar eminence (Fig. 9, a). The hand was held fixed in a position of pronation and volar flexion at the wrist; the fingers were flexed into the palm.

Under nitrous oxide anesthesia and through a bloodless field an incision was made first over the ulnar bursa in the palm to make certain whether the infectious process had extended distalward along the ulnar bursa from the forearm into the hand (Fig. 9, c). At this point the subcutaneous tissues were not indurated and the normal appearing flexor tendons of the little finger could be seen shining through the tendon sheath. The sheath was not opened. A second incision was made above the wrist just volar to the subcutaneous margin of the ulna (Fig. 9, d) and a large amount of thick pus evacuated from the retroflexor space. On gentle palpation the cavity was found to extend across to

the radial border of the forearm (Fig. 9, e) and upward to the middle of the forearm. The incision which had been previously made over the volar surface of the thumb was enlarged so as to drain adequately the sheath of the flexor pollicis longus in the palm (Fig. 9, c) and expose the fragmented and seminecrotic flexor tendon. Large warm wet dressings were applied as high as the shoulder and an electric baker placed over the extremity.

Cultures of the pus obtained from the retroflexor space in the forearm subsequently showed a heavy mixed growth of hemolytic streptococcus and *Bacillus pyocyaneus*, and a few colonies of *Staphylococcus aureus*.

Following operation the patient improved slowly but steadily. November 29, 4 days after operation, intermittent soaking of the hand and forearm in a sterile bath was substituted for the continuous warm wet dressing and in the intervals the hand laid on a light aluminum splint designed to bring it into dorsal flexion at the wrist and permit movement and particularly extension of the fingers. December 2 the albumin and red cells had disappeared from the urine and the leukocyte count dropped to 9100. December 5 her temperature for the first time did not rise above 99 degrees. She was dismissed from the hospital December 9 with the drainage wound on the ulnar side of the forearm red and granulating, but with considerable discharge still present from the incision over the flexor tendon of the thumb. The latter diminished rather rapidly after the remains of the necrotic flexor tendon were lifted from the wound.

Following her dismissal from the hospital every effort was made gradually to increase the movements of the fingers, which were almost fixed in flexion when she was admitted to the hospital, and to overcome the tendency to maintain the hand in pronation and volar flexion at the wrist joint. The progress attained in these respects is indicated in the photographs obtained February 10 (Fig. 10).

CASE 14. J. R. Passavant Memorial Hospital 13564 April 1-18 1933

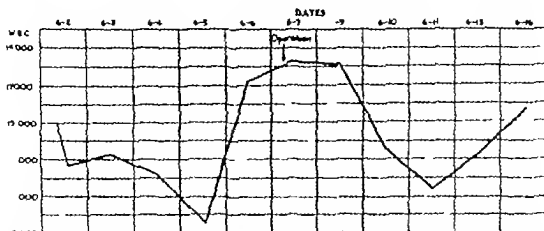


Fig 3 Case 8 Graph showing variation in leucocyte count during stage of acute infection.

This patient, an iceman of 35 years, sustained a cut over the palmar surface of the interphalangeal joint of the left thumb from a piece of tin projecting from an ice box on Friday morning, March 31. On awakening at 5:30 the next morning he noticed pain and tenderness and slight swelling over the palmar aspect of the thumb. These symptoms increased during the day. At 3:00 p.m. he was sent to a physician, who froze the thumb with ethyl chloride and incised it. Within a few moments the patient was seized with a chill and complained of feeling very ill. He was immediately put in a cab and brought to the hospital.

When I first saw him at the hospital at 4:15 p.m. his temperature was 103.8 degrees, his pulse 96; he was still trembling and complaining of feeling cold. The left thumb was bleeding at the site of the palmar incision in the distal phalanx. The entire thumb was dusky and moderately swollen. A broad red band could be seen extending upward along the middle of the volar surface of the forearm, turning posteriorly over the medial aspect of the elbow. A large warm wet dressing was immediately applied to the entire upper extremity and forced administrations of fluids begun.

During the next 4 days the patient's temperature fluctuated between 100 and 104.6 degrees; his pulse between 80 and 110. He complained bitterly of the persistent pain, and was constantly drenched in perspiration. His leucocyte count on admission was 18,200. April 4 it had dropped to 9,000. On April 4 the tension and tenderness over the entire palm, the exquisite pain produced by even slight passive extension of the semiflexed fingers, the numbness of the finger tips, the tension and tenderness over the wrist joint and the tense brawny swelling of the volar surface of the forearm pointed toward the extension of infection upward along the radial and into the ulnar bursa (Fig. 11) and possibly already rupturing from the bursa into the retroflexor space above the wrist. The persistent presence, however, of a band of redness, an inch in width, extending upward over the medial aspect of the arm, the obvious prostration of the patient and the sharp drop in the leucocyte count made us very apprehensive that any

operative procedure would be followed by a severe reaction and a rapidly developing and probably fatal septicemia.

Conservative treatment was therefore continued. April 5 the temperature fell a little lower, and 2 days later dropped below 100 degrees for the first time. April 6 the hand and forearm were both less tense and the red band over the medial aspect of the arm had disappeared. April 10 although the upper two-thirds of the forearm were still swollen the tense brawny induration had been replaced by a rather soft edema. April 11 the leucocyte count had risen to 13,200 and the lower third of the forearm was beginning to show a slight bulging swelling as compared with the upper two-thirds. By this time, because of the constant application of the warm moist dressings considerable maceration and superficial necrosis had taken place, particularly over the volar and dorsal aspects of the wrist (Fig. 12).

April 13 under nitrous oxide anesthesia the hand and forearm were incised. The four typical incisions for drainage of the ulnar bursa in the palm, of the

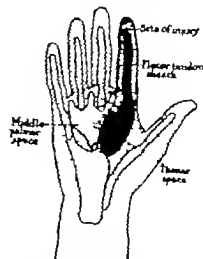


Fig 4 Case 8 Diagram showing site of injury and extension of infection. Stippled area indicates extent of intense inflammatory reaction; solid black area, site of abscess formation.

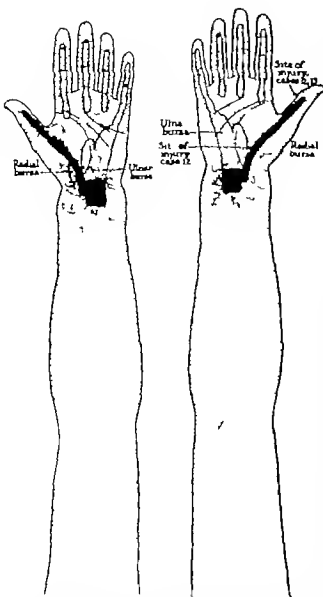


Fig. 5 left Case 6 Diagram showing site of injury and extent of infection. Stippled area indicates extent of intense inflammatory reaction; solid black area, site of abscess formation.

Fig. 6 Cases 1 and 13 Diagram showing sites of injury and extension of infection. Stippled area indicates extent of intense inflammatory reaction; solid black area, site of abscess formation.

flexor tendon sheath of the little finger of the retroflexor space above the wrist and of the tendon sheath of the flexor pollicis longus in the palm were made. Pus was evacuated through each incision. Cultures of the pus obtained from the ulnar bursa in the palm (the first space incised) subsequently showed a pure growth of a non-hemolytic streptococcus.



Fig. 7 Case 1. Degree of function present 12 weeks after injury and 9 weeks after incision and drainage of tendon sheath of flexor pollicis longus in the palm, and of radial bursa and retroflexor space in the forearm.

Following operation the patient improved rather rapidly. From April 15 to 18, the day of his dismissal from the hospital, his temperature ranged from 98.2 to 100 degrees and reached the latter level only once during the 4 days. April 18 he was transferred to another hospital so that he might be under the direct care of his company doctor.

The condition of his hand 6 weeks and 9 months after operation is shown in Figures 13 and 14.

CASE 15 S. P. Passavant Memorial Hospital, 6380 April 28 May 29 1931.

This patient, a butcher of 45 years, accidentally scratched the volar surface of his left thumb while at work Monday April 20. He paid no attention to the injury and continued with his work. In the evening the thumb felt stiff and painful but no treatment was instituted. He continued work for the next 3 days, but by the evening of April 23 the entire hand and wrist had become swollen, red, and painful. In spite of increasing symptoms of inflammation and of upward extension of the infection he refused to enter the hospital until the afternoon of April 28. At that time his temperature was 104.2 degrees, his pulse 104. The entire left hand, wrist, and forearm were tremendously swollen and inflamed. Over the dorsum, particularly the skin was tense from tension and over a few small areas superficial necrosis had already taken place. Above the area of diffuse redness, red streaks of lymphatic extension could be seen extending upward above the elbow.

With constant application of large warm wet dressings to the entire upper extremity the process gradually subsided and then receded in a step like descent. By May 9 it was obvious that a localized abscess had formed over the dorsum of the metacarpus, and a small incision was made under nitrous

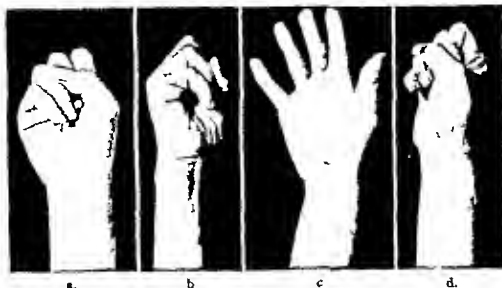


Fig. 3. Case 15. Degree of function present 13 weeks after injury and 15 weeks after incision and drainage of retroflexor space in the palm and of radial wrist and retroflexor space in the forearm.

oxide anaesthesia over the dorsum of the second metacarpal.

Cultures of the thin pus evacuated subsequently showed a pure culture of a hemolytic streptococcus.

Warm wet dressings were continued for another 7 days then intermittent soaking and dry dressings were substituted for the continuous wet dressing and movement of the fingers begun. When the patient was dismissed from the hospital May 29 the drainage wound was almost healed and he was moving his fingers fairly well.

CASE 16 H B Cook County Hospital 1272431 February 17-March 1 1932

This patient, a laborer of 54 years, sustained a superficial laceration over the dorsum of the middle metacarpophalangeal joint of the right hand in a fist fight Monday afternoon, February 15. Wednesday morning he awoke with a severe pain in the hand and was admitted to the hospital at 2 o'clock the same afternoon.

On admission his temperature was 101 degrees, his pulse 88, and he was obviously very ill. The hand was greatly swollen the dorsal surface was dusky of a reddish purple color. Over the middle metacarpophalangeal joint was a small laceration from which thin pus was draining. Definite red streaks extended upward over the dorsum of the forearm and medial surface of the arm. No glands could be palpated in the epitrochlear region or axilla.

Massive warm wet dressings were applied immediately to the entire extremity and continuous heat maintained over them with a "light cradle." The routine of forced fluids and continued bed rest was faithfully carried out. During the succeeding 5 days swelling and redness gradually extended farther proximalward until it reached the junction of the upper and middle thirds of the arm then it began gradually to recede. On February 24 it was evident that a considerable accumulation of pus had formed

under the skin over the metacarpus (Fig. 15). This was drained under nitrous oxide anaesthesia by a single incision over the center of the fluctuating area. A considerable quantity of pus was evacuated. Smears of the pus showed large numbers of streptococci and clusters of staphylococci. Cultures of the pus subsequently showed both the streptococcus and staphylococcus to be hemolytic.

Warm wet dressings were reapplied to the hand and forearm and continued for 4 days. Intermittent soakings followed by dry dressings, were then substituted for the continuous warm wet dressings and the wound discharge was very markedly diminished when the patient was dismissed to the out patient department March 1.

CASE 17 E B Passavant Memorial Hospital, 8794 9013 December 14, 1931-January 2 1932 January 6-16 1932

This patient, a physician of 35 years, while performing an autopsy Sunday morning, December 13 sustained a slight knife cut over the dorsum of the left little finger just distal to the proximal interphalangeal joint. He stated that the autopsy was on the body of a patient who had died of a bone sarcoma that 25 days earlier an autopsy had been performed on the body of a patient with a virulent streptococcal infection and that 2 other autopsies had been performed in the interim. Immediately after the injury he took off his glove and kept his hand wet until the autopsy was completed some 30 minutes later. He then washed the finger with 80 per cent alcohol solution and applied a dressing.

At 9:30 p.m. he first noticed pain about the site of injury. He held the hand for an hour under warm running water and then applied a dressing saturated with hexylresorcinol. At 1:00 a.m. he awoke with sharp pain and a feeling of tension about the site of injury. He applied a warm boric dressing and went back to sleep. At 4:00 a.m. he again awoke with pain



Fig. 9. Case 3. Infection of tendon sheath of flexor pollicis longus, of radial bursa, and of retroflexor space of forearm after a slight injury of volar surface of thumb a, b. Before operation c, d, e. Immediately after opera-

tion. Note in c exploratory incision for examination of ulnar bursa in palm, and incision for drainage of tendon sheath of flexor pollicis longus in palm, and in d incision for drainage of retroflexor space in forearm.

in the hand. At that time he first noticed red streaks extending up the forearm and arm. His temperature at that time was 103 degrees.

I first saw him at 9:00 a. m. Monday 22 hours after the injury. A small amount of seropurulent discharge was coming from the $\frac{1}{4}$ inch cut on the dorsum of the little finger. The dorsal surface of the finger was swollen, the hand was slightly swollen. On the dorsum of the forearm were several irregular and indistinct red streaks. Over the middle of the medial aspect of the arm were two distinct red streaks, $\frac{1}{4}$ inch wide and $\frac{3}{4}$ inch apart, extending straight upward to the axilla. No axillary glands could be palpated.

When he reached the hospital, a half hour later his temperature was 100.6 degrees, his pulse 98, his leucocyte count 18,800. A large warm wet dressing was immediately applied to the entire left upper extremity and an electric heater placed over it.

During the succeeding days the patient became intensely ill. The swelling and inflammation of the hand gradually increased and extended upward above the elbow. A peptic ulcer which had previously responded well to mucin treatment, flared up and gave him very acute distress. December 16 the red streaks had completely disappeared. December 18 the swelling and inflammation had reached to the junction of the lower two-thirds and the upper one-third of the arm. There it remained stationary for a few days, and then gradually began to recede. December 22 the redness and swelling had practically disappeared from the arm, and the forearm was less swollen, a sense of deep fluctuation over the dorsum of the hand suggested that localization might be taking place. December 23 a large, thin walled blister had formed over the dorsum of the metacarpus. When the blister was punctured considerable thin gray pus escaped and a small opening could be seen in the skin over the middle of the metacarpus

from which similar pus was escaping. Culture of this pus subsequently showed a heavy growth of a hemolytic streptococcus and an occasional colony of staphylococci.

The continuous warm wet dressing which had been replaced by an intermittent wet dressing for 3 days, was reapplied but no attempt was made to enlarge the small drainage wound or to facilitate the escape of pus. During the next 24 hours there was a profuse discharge of thin grayish purulent material and the opening in the skin increased to a diameter of $\frac{3}{4}$ inch. Twenty-four hours later on Christmas day the patient had a chill, his temperature, which had been remaining at a level of 99 to 100 degrees, rose abruptly to 103.8 degrees and his leucocyte count to 26,000 (Fig. 16). There was no evidence of thrombophlebitis, but a little more swelling and redness of the lower forearm with some indications of abscess formation there. A second opening also appeared distally and to the ulnar side of the first opening, and in the meantime the first had increased somewhat in size. During the next 24 hours the temperature dropped almost as abruptly as it had risen and reached normal at noon December 26. There after it did not rise above 98.8 degrees. The wound discharge gradually diminished, and as it did so the redness and swelling of the forearm receded.

January 6 the wound discharge had become seropurulent and very thin. The raw surface on the dorsum of the metacarpus had increased to a diameter of $\frac{3}{4}$ inch and was becoming covered with granulation tissue (Fig. 17 a). The dorsum of the fingers, hand and wrist was constantly of a dusky red color but the inflammatory reaction had practically disappeared from the forearm. When the patient was dismissed from the hospital January 19 the open wound at the site of drainage was almost healed.

The final result is shown in Figure 17 b, c.



Fig. 10 Case 13 Degree of function present 4 months after operation.

CASE 18 M. D. Nurses Infirmary Cook County School of Nursing March 25-May 6 1933

This patient a nurse of 21 years scratched herself on the dorsum of the right thumb with her left thumb nail 2 days before admission to the hospital. The day after the injury the right thumb became sore the same evening she noticed signs of inflammation and a red streak extending upward along the dorsal aspect of the thumb. She was admitted to the hospital on the following day on the service of Dr. Paul Rhoads with a temperature of 100 degrees, and a pulse of 136. At that time the redness and swelling had extended upward to the middle third of the forearm and the patient complained of intense pain in the inflamed area. A large warm wet dressing was immediately applied to the right upper extremity and external heat maintained over it.

During the next few days the inflammatory process gradually extended proximalward, and as it did so the swelling of the dorsum of the hand became less indurated. The patient's temperature in the mean time fluctuated between 98 and 103 degrees, her pulse between 96 and 142 and her leucocyte count between 19,000 and 13,600. March 29 under nitrous oxide anesthesia three longitudinal incisions were made over the dorsum of the hand by Dr. Edwin Miller and a considerable amount of yellow pus evacuated. Cultures of this pus subsequently showed a pure growth of a hemolytic streptococcus.

In spite of the liberation of pus from the dorsum of the hand the inflammatory process continued to extend upward. March 31 a second operation was performed by Dr. Miller and an incision 12 inches

long was made from the dorsum of the hand almost to the elbow. Through this incision a considerable amount of free pus and sloughing tissue was evacuated from the dorsal aspect of the forearm.

When I saw the patient first on April 3 she was complaining of pain over the medial aspect of the arm. The soft tissues above the elbow were red and inflamed but not indurated. Massive warm wet dressings were applied as high as the shoulder and conservative treatment advised. Thereafter the inflammatory process gradually subsided and no further extension took place. April 25 Dr. Miller was able to excise the granulation tissue from the forearm wound undermine the skin edges and bring them together with silk sutures. No reaction developed after this procedure and the patient was dismissed May 6 with the drainage wounds almost healed, but with a short rough systolic murmur at the apex which was not present when the patient was admitted to the infirmary, and which Dr. Rhoads believed had developed during the course of her infection.

Following her discharge from the hospital she remained at home until June 26 and during that period gained 20 pounds in weight. On her return to duty the systolic apical murmur first noted May 2 was still present but she showed no evidence of cardiac embarrassment.

CASE 19 R. K. 1340936. Cook County Hospital February 17-28 1933

This patient, a girl of 4 years was admitted to the children's surgical ward with a history of pain and swelling of the left forearm of 5 days duration. She

first complained of tenderness and pain Sunday night, February 12. The next morning a doctor who was called noted that the child was feverish and fretful and that there was limitation of motion of the left upper extremity. By Wednesday the forearm had become swollen and red in spite of the cold applications and the rubbing with oil of winter green, as prescribed.

On admission February 17 the patient was feverish and irritable. Her temperature was 103.4 degrees, her pulse 100, her leucocyte count 16,800. The palm of the left hand was swollen and tense, the entire forearm inflamed, brawny and indurated. There was some swelling above the elbow. A large warm wet sterile dressing was applied to the entire upper extremity and a light cradle kept over it continuously.

Four days later it was obvious that liquefaction had taken place and that the brawny indurated mass had become converted into a sac of pus. Through a 2 inch incision on the medial aspect of the lower end of the forearm a large quantity of thick fluid pus, lying superficial to the deep fascia, was evacuated. Cultures made from the pus subsequently showed a pure growth of a hemolytic streptococcus. Following incision recovery took place rapidly and the patient was dismissed from the hospital February 25 with a flat granulating wound at the site of the drainage incision.

Although in this case we had no history of an injury of the hand as the etiological factor for the rapidly spreading infection, the course of events so closely simulates that seen in a number of other cases that we feel justified in including this case with the group under discussion.

CASE 20 J. R. 1257693 Cook County Hospital November 24, 1931-February 10, 1932.

This patient, a workman of 28 years, sustained a penetrating wound of the dorsum of the left hand just distal to the metacarpophalangeal joint of the middle finger from a steel nail, 36 hours before admission to the hospital. He paid no attention to the injury at the time of its occurrence but 12 hours later pain became so severe that he was unable to sleep and at the same time he noticed swelling and red streaks extending upward toward the elbow.

On admission to the hospital the hand was swollen and edematous, particularly on its dorsal aspect. A small puncture wound could still be seen over the base of the middle finger. Numerous red lines were present over the forearm and arm extending upward to the cubital and axillary fossae. Hot spreads were applied and antitetanic serum given.

When I first saw the patient 3 days later his temperature was fluctuating between 100 and 103 degrees, his pulse between 120 and 130. The entire left upper extremity had become swollen, inflamed, and indurated. The superficial tissues over the dorsum of the hand and wrist were undergoing necrosis and thin yellow pus was oozing from these areas. Here and there over the dorsum of the forearm were large blisters filled with thin turbid fluid.

The whole extremity had a dusky cyanotic tinge, and over the medial aspect of the arm were still present red bands indicating the extension of the infection along the main lymphatic trunks. The appearance of the upper extremity at that time is well illustrated in the colored frontispiece (Fig. 18).

For the next week conservative treatment was continued, the entire extremity above the wrist was kept enveloped in a large warm wet sterile dressing over the hand and wrist because of the maceration and necrosis of the superficial tissues, dressings saturated with Dakin's solution were applied and changed twice in each 24 hours. Fluid was given in maximum amounts and pain controlled with opiates. From November 27 to December 3 the patient's temperature ranged from 99 to 103.4 degrees, the pulse from 88 to 120. December 5 evidence of softening appeared over the dorsum of the forearm, and within 48 hours the diffuse brawny induration which had extended from the wrist to the axilla was replaced by widespread softening and fluid formation. December 7 under nitrous oxide anesthesia, two longitudinal incisions were made in the forearm and one above the elbow so as to secure maximum and dependent drainage. Liquid pus literally poured from each incision; it seemed as though the entire mass of subcutaneous tissue had been transformed into fluid and stringy necrotic material. At no point was there evidence that the infection involved the deeper tissues or that abscess formation had taken place underneath the deep fascia.

Thereafter recovery was slow but uneventful. December 21 the patient's temperature became normal. December 23 two incisions were made in the forearm to secure better drainage, for in two areas wound discharge tended to become pocketed underneath the overlying skin. As invariably happens with drainage incisions made on the dorsum of the forearm, wide separation of the skin edges at the sites of incision took place and healing was delayed by this separation and because of the extensive necrosis of skin and superficial tissues on the dorsum of the hand and wrist which had occurred in the course of the first week.

When the patient was dismissed from the hospital February 10 the granulating wounds were quite small. The appearance of the hand and forearm and the range of movement present March 15 1932 are shown in Figure 19.

CASE 21 M. H. Cook County Hospital, 1321918 November 7-December 14, 1932.

This patient, a Mexican workman of 45 years, sustained a slight penetrating wound from a piece of wire over the dorsum of the metacarpophalangeal joint of the left middle finger 5 days before admission to the hospital. Pain, redness, and swelling of the dorsum of the hand appeared within 12 hours.

On admission to the hospital the entire hand and forearm were inflamed, markedly swollen, and indurated, the swelling had already extended above the elbow and over the medial surface of the arm were two distinct red bands extending to the axilla.

Several large blisters had formed over the dorsum of the hand and wrist underneath them necrosis of the skin had taken place, and from the open wounds there was a profuse discharge of light yellow seropurulent fluid.

Shortly after admission the entire upper extremity was surrounded with a massive warm wet sterile dressing and external heat was applied over it with the aid of a light cradle. This treatment was continued for the next 5 days fluids were given in as large amounts as possible and sedatives to control the pain. In spite of the fact that his recorded temperature and pulse rate did not rise above 102 degrees and 108 during this period, the patient's condition obviously became increasingly serious. During this period also, the swelling of the hand and forearm gradually increased and involvement of the arm became more marked. Except over the dorsum of the hand, where the tissues had broken down, the swelling was everywhere brawny indurated and resistant to the touch the entire upper extremity was livid, with a persistent cyanotic tinge.

On the fifth day after admission to the hospital a diffuse softening of the firm and indurated subcutaneous tissue began to develop in the upper extremity. Within 48 hours the entire forearm and arm were literally transformed from a uniformly tense indurated mass into an elongated sac of pus. On the seventh day under nitrous oxide anesthesia, three vertical incisions were made at the most dependent portion of the extremity as the patient lay with his arm extended—one over the lower portion of the forearm, one over the upper and one above the elbow. Liquid pus literally poured from each incision the entire mass of subcutaneous tissue seemed to have been converted into fluid and stringy necrotic material but the process did not extend beneath the deep fascia nor were the muscles or tendons exposed.

Following operation the patient's temperature promptly dropped to normal the abdominal pain and distention which had developed during the days immediately preceding the operation disappeared and recovery gradually took place. A profuse purulent discharge from the operative incisions persisted for some time but gradually diminished with the aid of irrigation with Dakin's solution and care not to reinflect the open wounds.

The patient was dismissed from the hospital December 14 1932 exactly 1 month after operation with the raw surfaces almost healed. At that time the largest unhealed area and the greatest amount of scar tissue formation were over the dorsum of the hand and wrist where necrosis of the superficial tissues had been most marked and had taken place early in the course of the disease.

CASE 22 E N Cook County Hospital 1402782
December 15 1933—January 20 1934

Six days before admission this patient an undernourished and rather frail old man of 68 years, fell and injured his right hand. He was treated at the Green Street Shelter but swelling and inflammation

began soon after the injury and gradually involved the forearm and arm.

On admission to the hospital on the evening of December 15 he was obviously very ill, his temperature was 103.6 degrees his pulse 92. The hand forearm and arm were inflamed swollen, tense, and indurated. Over the dorsum of the thumb was a small infected ulcer. The epitrochlear glands were enlarged and tender.

The entire upper extremity was enveloped in a warm wet dressing and forced administration of fluids begun. For the next 7 days this treatment was maintained, although in view of the patient's age and general condition it seemed unlikely that he could overcome the widespread infection. During this time he was constantly irrational and incontinent, his recorded temperature ranged between 100 and 103.6 degrees, his pulse between 88 and 103.

December 22 7 days after admission, it was evident that the indurated subcutaneous tissue had undergone extensive liquefaction. Under local anesthesia with 1 per cent novocain the forearm and arm were incised and a profuse amount of pus liberated. Following operation his condition gradually improved. His temperature dropped to normal December 27 at the same time the involuntary urination and defecation ceased except for an occasional lapse, and in spite of pressure sores which had developed during the period of incontinence he was able to sit up in a wheel chair on January 6.

The profuse purulent drainage from the forearm and arm gradually diminished with the aid of irrigation with Dakin's solution, and later, daily soakings in warm sterile soapy water and he was discharged from the hospital January 20 with only a slight amount of serous drainage at the site of the operative incisions.

This group of cases, in which the inflammatory process advanced very rapidly at first then more slowly then became stationary, and finally receded is of particular interest because it is especially in this group of cases that we believe the function of the hand and in some cases the patient's life were saved by careful nursing and careful surgical treatment.

A number of interesting facts stand out in connection with this third group. First, that infections arising on the palmar surface of the hand and fingers are particularly serious, and that of the infections arising on the dorsum those which begin in the middle finger spread upward most rapidly. These clinical observations are in accordance with two facts pointed out by Poirer and Cunéo and frequently emphasized by Kanavel that the collecting lymphatics of the hand and forearm pass from the volar to the dorsal surface and then extend

proximalward (Fig 19) and second that while the collecting lymphatics from the ulnar side of the hand drain into the epitrochlear glands, and those from the radial side of the hand into the axillary glands, the lymphatic vessels from the middle of the hand tend to pass by epitrochlear and axillary glands and drain into the supraclavicular glands or even into the main lymphatic channels that join the subclavian vein (Fig 21).

With reference to the first fact—that the direction of lymphatic drainage is from the volar to the dorsal aspect of the hand and forearm—it seems unquestionable that the flow of lymph from a site of inoculation on the palmar surface of the hand not only involves all the deeper cellular tissues of the hand as the infection is carried proximalward and dorsalward but that it can also result in infection of one or more of the synovial lined cavities—the tendon sheaths the radial and ulnar bursa and the joints of the wrist or carpus—as the lymphatic stream drains proximalward. Once infection enters such a space it tends to spread rapidly and without hindrance throughout the extent of the space. Absorption from such an extensive area is marked; it can be likened to the absorption which takes place on a larger scale from the large serous cavities in the abdomen and chest. Further secondary extension into all the adjacent tissues will undoubtedly take place rapidly if a wide area of involvement, such as an infection of the entire radial bursa for example, is present.

If the original site of inoculation on the contrary is on the dorsum of the hand the direction of lymphatic drainage from this site is upward toward the elbow and axilla, but not toward the volar surface of the forearm and arm. As the infection spreads the latter areas gradually become involved by direct extension but the involvement affects particularly the subcutaneous tissues, and we have not at any time seen abscess formation within a flexor tendon sheath or within the radial or ulnar bursa in a patient in whom the infection started in a wound of the dorsal surface of the hand. In other words, if the infection begins on the palmar surface of the hand because of

the direction of lymphatic drainage the entire hand and forearm become involved if the infection arises on the dorsum the tendency is for it to spread upward in the subcutaneous tissues and remain confined to the dorsal surface and to the subcutaneous tissues of the volar surface.

The course of events in this group of cases followed one of three fairly distinct and characteristic patterns, and we believe this fact also deserves emphasis. The first pattern was seen in patients with infections beginning on the volar surface of the hand (Cases 8-14). In these cases the early symptoms, in addition to rapidly ascending inflammation and rapidly increasing swelling of the hand of the forearm and in some cases of the arm were persistent excruciating throbbing pain and a feeling of excessive tension. These patients persistently complained that the hand and the lower part of the forearm felt as though they would burst. On gentle palpation one could not find evidence of excessive tension over the area complained of nor in the cases in which the infection began in the thumb (Cases 10, 11) did there seem to be an increase of pain on gently extending the thumb—a symptom to which Hanau¹ ascribed the greatest importance in recognizing the presence of infection within the tendon sheath. After a few days these symptoms become less marked though we never noticed in these cases any diminution of sensation in the area of median or ulnar nerve distribution; a well recognized but late symptom of infection spreading from the radial to the ulnar bursa or vice versa through the common flexor sheath above the wrist.

After varying periods the swelling and tension recurred but the second time with definite symptoms of a localizing infection—localized redness, localized swelling and fluctuation. When this area of localized infection was finally incised and drained healing took place rather rapidly.

Interestingly enough in both of these cases (Nos 10 and 11) as well as in a third case (No 13) of this group in which the infection began on the volar surface of the thumb the

¹W. C. HANAU says that this may not have been proved, it was not consistently looked for.

abscess formation took place in the tendon sheath of the flexor pollicis longus, the radial bursa, and the common flexor sheath above the wrist, but did not extend into the ulnar bursa within the palm and the tendon sheath of the little finger (Figs. 5-6). This fact suggests the possibility that when pus forms rather slowly within a serous lined cavity (the tendon sheath) as a result of lymphatic drainage into it rather than direct inoculation of the opened sheath, there is time for a walling off process to develop¹ and rapid extension along all the communicating channels is not so likely to take place particularly if some barrier, such as the taut anterior annular ligament pressing upon the bursa from above is present to help obstruct the pathway. In the only case (No. 14) of this group in which the infectious process did extend along all the communicating channels i. e. from the tendon sheath of the thumb and radial bursa into the ulnar bursa distalward in the palm and finally into the digital sheath of the flexor tendons of the little finger (Fig. 11)—the extension took place rapidly and the symptoms of such extension were present 4 days after the initial injury. Because of this patient's serious condition however operation was delayed in the belief that early incision would prove disastrous and the actual demonstration of the spread of infection was delayed for 13 days. In Cases 10 and 11 on the other hand definite symptoms of infection within the sheath of the long flexor tendon of the thumb and within the radial bursa were not present for 14 and 20 days respectively after the onset of the infectious process and in these cases the suppurative process did not extend along the entire pathway i. e. it did not extend into the ulnar bursa within the palm and the digital sheath of the little finger (Figs. 5-6).

The 2 other patterns in this group were seen in patients with infection beginning on the dorsum of the hand. In these cases one of two things occurred. In certain cases (Nos. 15-18) the swelling and inflammatory reaction extended rather rapidly up the forearm then more slowly up the arm and finally came to a

halt at a level somewhere between the level of the elbow and the shoulder. After remaining stationary for from 24 to 72 hours the swelling and inflammatory reaction gradually began to recede and eventually abscess formation took place usually over the dorsum of the metacarpus. In 4 other cases (Nos. 19-22) the swelling and inflammatory reaction progressed in the same way until the whole upper extremity was tremendously swollen and diffusely indurated. After remaining apparently stationary for several days rather suddenly within 24 or 48 hours the tense and indurated subcutaneous tissue was transformed into fluid and the upper extremity changed from an indurated cylindrical mass into an elongated sac of pus.² When this was opened and drained it was found that the liquefaction and pus formation was confined to the subcutaneous tissues and lay entirely outside the deep fascia.

GROUP 4 FATAL CASES

CASE 23. V. M. Jasper County Hospital, Rensselaer, Indiana, June 10, 1933.

This patient, a frail 4 year old girl sustained an abrasion of the hypotenar eminence of the left hand on June 6. The hand was washed and bandaged. Two days later a dry crust had formed at the site of injury. The same afternoon she fell in the street striking the hypotenar eminence of the same hand against the curb. The dry crust was broken and some bleeding took place.

The following evening June 9 because she complained of a sore throat she was taken to the office of Dr. M. D. Gwin. He found the tonsils and pharynx acutely reddened, but no yellowish patches or membrane could be seen. The mucous membrane of the mouth and gums was normal. Over the hypotenar eminence of the left hand was a dark crust surrounded by a circle of acute inflammatory reaction. The patient's temperature was 103 degrees. The hand was dressed with a wet dressing and the patient told to report the next day.

The next morning according to the mother's statement, a bluish area had appeared at the center of the palm. The parents and patient immediately started for the hospital 15 miles away but by the time of their arrival the entire hand had become swollen and cyanotic. The patient was immediately put to bed, a massive warm wet dressing was applied and fluids were given by proctodysis. In spite of these measures the swelling and cyanosis extended upward with almost incredible rapidity. When I saw the child at 5:00 p. m. she was very restless and

¹The slowly penetrating pyogenic ulcer with local pyostoma, as distinguished from the acute perforating with rapidly developing and widespread pyostoma may offer an analogy.

²This is the type of case which Koss has described as well under the heading "Gangrenous Infections of the Hand" (Ch. 6th ed. pp. 231-247).

tossing about in delirium. The swelling had involved the entire upper extremity and the hand itself had become cold and lifeless. During the remaining 5 hours of life the discoloration and cyanosis continued to spread, and had involved practically the entire body when the child died at 10 00 p.m. 54 hours after the second injury.

CASE 24. V. M. Nurses Infirmary Cook County School of Nursing, April 1-7, 1932.

This patient, a nurse of 24 years, pricked her right thumb with a pin the day before admission to the infirmary. Soon after she noticed pain and redness in the thumb. Two days before admission she had received her first immunizing dose of scarlet fever toxin, and the evening before admission she felt chilly, had a headache, sore throat and diffuse muscular pains.

She was admitted to the infirmary under the care of Dr. Paul Rhoads at 3 00 p.m., April 1, obviously acutely ill with a temperature of 104 degrees, and a pulse of 126. The right thumb was red, swollen, and tender particularly over the palmar aspect of the distal phalanx. The palm and dorsum of the hand were not yet involved. Red streaks of lymphatic involvement extended upward along the volar surface of the forearm toward the antecubital fossa. The leukocyte count was 21,600, with 84 per cent of polymorphonuclear cells. A large warm wet dressing was applied to the right upper extremity and forced administration of fluids begun.

When I saw her first on the afternoon of April 4 she was complaining bitterly of persistent pain in the hand and forearm. The swelling and inflammatory process had extended upward, and now gave the picture of an acute, diffuse cellulitis involving the entire hand and forearm. Over the palmar surface of the distal phalanx of the thumb at the site of the original injury was a vesicle filled with dark serum. Over the medial aspect of the arm were red lines extending toward the axilla. Although the patient complained of intense pain, gentle movement of the thumb toward extension did not cause exaggeration of the pain.

During the succeeding days her condition grew steadily worse. April 6 the thumb, index finger, and thenar eminence had become gangrenous and the phlegmonous process had involved the entire arm. Although her temperature fluctuated between 98 and 101 degrees until 24 hours before death her pulse rose in almost an unbroken line from a level of 100 just after admission to 170 just before death at 1 40 p.m. April 7.

Cultures of the serum obtained from the blister on the patient's thumb showed a pure growth of a hemolytic staphylococcus. A blood culture remained sterile after a number of days incubation.

CASE 25. P. F. Nurses Infirmary Cook County School of Nursing, October 16-20, 1933.

This patient, a graduate nurse of 28 years, pricked the volar surface of the distal phalanx of the left thumb with a safety pin October 15. Within a few hours she noticed redness and swelling of the thumb,

and by evening red streaks on the volar surface of the forearm.

She was admitted to the Nurses Infirmary on the service of Dr. Paul Rhoads the evening of the following day with a temperature of 99.4 degrees and pulse of 74. The palmar surface of the distal phalanx of the left thumb was swollen and red. Red streaks of lymphatic extension could be seen on the radial side of the lower half of the forearm. A massive warm wet dressing was immediately applied to the entire upper extremity.

During the next 48 hours both the local inflammatory condition and the patient's general condition grew steadily worse. The swelling and inflammation which had begun in the thumb extended upward to the thenar area and the radial side of the forearm. She complained bitterly of intense throbbing, "thumping" pain in the thumb hand and forearm, which was only temporarily lessened by sedatives. Both Dr. R. T. Vaughan, who saw her October 17 and Dr. Edwin M. Miller who saw her October 18, advised continuation of conservative management and of administration of fluid in maximum amounts.

When I saw her on the evening of October 18 her temperature was 100 degrees, her pulse 110. A small area of superficial necrosis had developed about the site of the original pin prick. The tips of the index and middle fingers had become white and insensative.

The following morning the superficial tissue over the localized area of necrosis on the distal phalanx of the thumb was lifted away and a little thin seropurulent fluid underneath taken for culture. This subsequently showed a pure growth of a hemolytic streptococcus. No demonstrable exotoxin could be obtained by Dr. Rhoads from the filtrate of this organism. During the day the patient's pulse rose steadily, she complained persistently of pain, and moaned and tossed in a toxic delirium. Her abdomen gradually became distended, and as the swelling of the hand and forearm progressed the distal two thirds of the thumb became cyanotic. She died at noon, October 20, just 5 days after the initial injury.

CASE 26. E. B. Garfield Park Hospital, 30903 January 21-23, 1930.

This patient, a housewife of 35 years, sustained a slight cut of the right index finger as she was peeling an orange on Saturday, January 18. At noon of the following day, when she first became aware of pain and swelling involving the finger and hand, she applied warm boric acid dressings every half hour phenol and yellow oxide paste "to draw it," but no relief was obtained.

Tuesday morning, January 22 she consulted Dr. W. A. James, and at 10 00 a.m. of the same day was admitted to the hospital with a temperature of 99.4 degrees and a pulse of 86. On admission it was noted that the arm was "tense, hot, and swollen from the shoulder down." Shortly after admission a blood count showed 56,200 leukocytes with 94 per cent polymorphonuclear cells. Hot boric compresses were immediately applied to the entire right upper extremity.

Because of the obvious seriousness of the patient's condition Dr. James called a second surgeon into consultation who advised immediate operation. At 1:45 p.m. under ethylene anaesthesia incisions were made on each side of the volar surface of the fore arm, 2 to 3 inches above the wrist and an equal distance below the elbow and four rubber drains were inserted underneath or between the flexor tendons from one side of the forearm to the other.

Wednesday, January 23 although her temperature had not risen above 99.6 degrees or her pulse above 110 she was obviously worse. Dr. James noted, "The pulse is rapid. The hand is pale and cyanotic. There is extension of the infection above the elbow there is great pressure (tension) in the arm."

At 1:30 p.m. at the insistence of the consultant who had made the incisions in the forearm the day before, she was again taken to the operating room and incisions made above the elbow for through and through tube drainage.

At 9:30 p.m. she was given 50 cubic centimeters of antistreptococcal serum. When I saw her shortly afterward she was sitting up in bed with face flushed, eyes alert and the appearance of a person under the influence of some powerful artificial stimulant. Her temperature was 99.6 degrees, her pulse 120. The forearm and arm were greatly swollen. Thin serous fluid was oozing from beside the drains which had been inserted in the forearm and arm. The hand was cyanotic and cold. The thumb index, and middle fingers were lifeless and insensate.

Because of the comparatively brief duration of the infectious process, the high leucocyte count, the absence of high fever and the apparent sturdy constitution of the patient (she appeared to be a strong woman of 165 to 175 pounds) I advised amputation of the arm at the insertion of the deltoid. To this the husband could not make up his mind to consent unless a third physician, a personal friend, concurred in the recommendation. Before this friend could be reached 3 hours had passed by. The change that had taken place in the meantime was startling. Instead of appearing bright and alert the patient was obviously failing rapidly and profoundly toxic. Had I not urged amputation so insistently 3 hours before I would probably have had the courage when consent was finally given to admit that it was then too late.

Operation was carried out as rapidly as possible, but it was of no avail and the patient died 6 hours later at 7:35 a.m. January 23 less than 5 days after the initial injury.

CASE 27 J. B. Methodist Episcopal Hospital Indianapolis, Indiana December 20-24 1929

This patient, a physician of 61 years, sustained a penetrating wound of the volar surface of the distal phalanx of the left middle finger Wednesday evening, December 18. He had opened an infected blister for a patient during the afternoon and immediately replaced the scissors in his instrument bag. Later in reaching quickly into the bag he struck the middle finger against the point of the scissors. He im-

mediately painted the finger with several antiseptics, including phenol. Thursday a cold day, he took a long walk and became chilled. In the evening the finger began to throb and pain.

He was admitted to the hospital Friday morning on the service of Drs. J. H. Wynn and R. Wynn S. Owen and it was noted. The left middle finger is swollen, dark, discolored with appearance of developing gangrene. There is some swelling of the palm. There is lymphangitis extending to the elbow and some epitrochlear enlargement. There is no arterial adenyopathy. Patient is very toxic. No heart murmurs can be heard.

In spite of the application of large warm wet dressings the inflammatory process extended upward and the patient's condition grew steadily worse. Sunday morning December 22 Dr. Wynn noted that the purplish discoloration of the middle finger had become more marked, and a similar change was developing in the little finger. Swelling of the hand and forearm had become more extensive and dark blebs were appearing on the palm and over the volar surface of the wrist.

When I first saw him in consultation with Dr. Owen at 10:00 p.m. Sunday, December 22 the patient looked sick and feverish, his cheeks were hollow, his face moist. He was very restless and anxious. His temperature was 102 degrees, his pulse 110. The left hand was markedly swollen, the forearm moderately swollen, red lines and a band of lymphatic extension were present on the inner aspect of the arm. Both on the palm and dorsum of the hand were many blebs with thin serous fluid oozing from them. The middle and little fingers were purple, the middle apparently completely gangrenous and lifeless from the web distalward. The little finger was not so completely involved. There was no increase of pain on extending the fingers. The thenar eminence was very tense and thickened, with almost a sense of fluctuation. Just above the annular ligament there was definite swelling but not marked induration. When the skin forming the blebs was cut away the underlying tissues appeared red, edematous, almost gelatinous in spots, due to the intense edema of all the tissues.

The question of amputation was considered, but it seemed to us unlikely that the patient would be able to withstand the shock of such an operation, and improbable that the septic process would be checked even by a high amputation.

For the remainder of the history I am indebted to Dr. Owen. Throughout Monday, December 23 the patient's condition grew steadily worse. Rales over the bases of the lungs which had appeared December 21 became more distinct and were heard over a wider area. The breath sounds over the right base became less clear. On December 24 the patient became irrational and the sclera tinged with yellow. The spreading gangrene had involved all the fingers and there was beginning discoloration over the wrist. The swelling of the forearm and arm were practically unchanged.

Death occurred shortly before midnight December

24. **CASE 28** W. K. Woodlawn Hospital, 1040. September 2-14, 1928

This patient, a sturdy steamfitter of 48 years, 6 feet 3 inches tall, and weighing about 200 pounds, stated that he had sustained a silver wound of the left index finger on Saturday morning September 1. In the afternoon he went to a moving picture show and there became aware of intense discomfort in his finger. A little later he consulted a physician who applied an ointment and a dressing to the finger. By evening the finger had become swollen and intensely painful. Within another 12 hours the swelling had involved the entire hand, and he felt very ill and feverish.

Sunday morning, September 2, he was admitted to the Woodlawn Hospital on the service of Dr. James T. Gregory with a temperature of 100.4 degrees and pulse of 100. On admission, in addition to the pain and swelling of the hand, he complained particularly of weakness; he was unable to walk without assistance and had fainted twice before reaching the hospital. It was noted by the admitting interne, The hand is badly swollen, there are lymphatic streaks to upper arm, the patient is toxic.

Hot boracic dressings were applied to the hand and the patient given, first at 11:00 a. m. and an hour later 1/150 gr. scopolamine hypodermically. At 10:30 it was noted patient tossing and turning continually. At 11:55 a. m. because he was extremely restless and slightly irrational he was given 1 grain of morphine hypodermically; this was repeated at 1:00 p. m. 5:45 p. m. and 11:45 p. m.

The next day the interne noted, Much worse in every way hand developing blisters and the nurse noted, Dressing changed large amount of bloody drainage from third finger. Patient has two large blisters on back of hand. The blisters were opened a little later in the day and a considerable amount of bloody fluid evacuated.

Tuesday September 4, a blood examination showed 4,000,000 red cells, 10,600 white cells, and hemoglobin of 80 per cent. At noon, under ethylene anesthesia the hand was examined by Dr. Gregory. The record states, Examination of hand probed found thrombosis nothing done.

At 7:00 p. m. of the same day when I first saw the patient the entire hand and forearm were greatly swollen, the arm less so. Red streaks of lymphatic involvement were present on the medial surface of the arm. The thumb, index, and middle fingers were grayish purple in color and from these fingers the skin was separating in large grayish patches. Over the areas where the skin had been lifted away the underlying tissues were swollen and reddish purple like raw beef steak which has been exposed to the open air. Under ethylene anesthesia the middle palmar space and the ulnar bursa above the wrist were opened. A small amount of thin pus was obtained from both spaces. A large wet sterile dressing was applied from the finger tips to the shoulder

September 5 the interne noted Necrosis of hand more extensive lymphangitis more marked in upper arm and shoulder.

During the succeeding days, although the patient's general condition varied from time to time he steadily lost ground. The temperature, which had ranged between 99.6 and 101.4 degrees from September 2 to the afternoon of September 5 gradually became higher. The pulse rate remained remarkably constant varying from 85 to 108.

September 8 he became irrational again and thereafter his mental condition became more and more confused. On the same day the blood culture was reported as showing a short chain streptococcus, and it was noted, Hand gangrenous, line of demarcation appearing. September 9 it was noted that the shoulder was very red and swollen. September 11 he began to have involuntary urinations and defecations, and large reddish purple blotches began to appear over the face and left side of the body. On the same day his temperature began to rise to a higher level and from that day until the evening of his death September 14 showed an almost unbroken rise from 102 degrees at 8:00 p. m. September 11 to 107 degrees just before death. The recorded pulse rate during the last 3 days was not above 113.

CASE 29 J. H. Cook County Hospital, 1305675. November 25, December 22, 1933.

This patient a workman of 57 years, who appeared to be 10 years older was admitted to the hospital 7 days after sustaining a penetrating wound from broken glass on the volar surface of the left forearm 1 inch above the wrist.

On admission to the hospital his temperature was 99.8 degrees, his pulse 85. The entire left hand and forearm were diffusely swollen, red, and tender. A small amount of very thin seropurulent fluid was draining from the oblique volar wound just above the wrist. A large "hot spread" was applied to the entire upper extremity. When I saw the patient five days later his temperature was 103 degrees and he was obviously very ill. He talked incoherently and complained persistently of pain. There was a diffuse cellulitis of the hand, wrist and forearm with marked edema. Above the elbow were broad red streaks of lymphatic involvement extending proximally toward the axilla.

After 3 days, during most of which time his temperature had been 103 degrees or higher and his mental condition unimproved, because I thought a localized accumulation of pus had developed under the flexor tendons and beneath the site of the original injury an incision was made on the ulnar side of the forearm just volar to the subcutaneous edge of the ulna, and some thin pus, similar to that which had been draining from the superficial wound, evacuated.

During the next 3 days his condition gradually improved and his temperature receded though he re-

Although the actual injury in this case was upon the forearm and not the hand the case and its sequelae are included in the group of events which are identical with that seen in the majority and because of the special interest associated with the site of localization of the infectious process.

maintained very unco-operative, was irrational much of the time and having involuntary evacuations the greater part of the time. December 5 his temperature which had dropped to a level of 101-102.6 degrees (rectal) again began to rise to a level of 103.6-104 degrees, his pulse became irregular and he became semi-stuporous. At the same time a persistent cough developed with numerous moist rales over both sides of the chest posteriorly and expectoration of considerable amounts of mucus. Three days later a large reddened area appeared just above the buttocks, and this gradually gave way with the formation of a large bed sore. For days he remained irrational and incoherent with continuous high fever and continuous involuntary evacuations. It seemed almost incredible that he could still cling to life in view of the severity of the infection and his inability to take food though fluid intake was maintained by hypodermic morphia and glucose solution given intravenously.

By December 15 the inflammatory process in the left hand and forearm had receded very definitely and a boggy fluctuating mass had developed over the dorsum of the metacarpus. This was incised without removing the patient from his bed and a considerable quantity of thin grayish pus liberated. Thereafter his temperature again receded for a few days, but the diffuse pulmonary involvement which had appeared 10 days before gradually became more marked consolidation developed in both lower lobes and the patient died December 22 from an extensive bilateral bronchopneumonia.

CASE 30. E. E. P. St. Mary's Hospital, Streator, Illinois. May 17-28, 1932.

This patient a physician of 57 years, sustained a superficial tangential knife cut on the radial side of the middle phalanx of the left index finger while performing an autopsy Sunday May 15, 1932. Monday a blister had formed at the site of injury. Tuesday he was admitted to the hospital and the finger was opened. Subsequently he developed chills and a temperature of 101 degrees.

When I saw the patient first on Wednesday evening May 18 in consultation with Dr. Gordon Perisho there was diffuse swelling of the entire index finger and slight swelling of the thenar area with tension and throbbing pain in the finger and extending into the palm. The finger was held in slight flexion on moving it slightly into extension there was no pain but if further extension was attempted the pain was definite. There was moderate swelling of the palm, some redness of the forearm and arm with red bands of lymphatic involvement extending proximally. The patient's temperature had ranged between 102.2 degrees, on admission and 98.6 degrees.

A large warm wet dressing was applied to the entire upper extremity, and administration of fluid in maximum amounts begun. The patient was persuaded, with some difficulty, that he must remain quiet and constantly in bed. I did not see him again and am indebted to Dr. Perisho for the subsequent history.

In spite of the continued application of a massive warm sterile dressing the infectious process continued to spread. On Monday May 23, 8 days after the initial injury under gas anesthesia the finger was opened widely and drained. The following day the patient complained that the left foot felt numb. It was noted shortly afterward that the foot had become cold and that no pulse could be felt in the posterior tibial artery or the dorsalis pedis. May 26 he began to hiccup and continued to do so during the day and most of the night. By May 27 the spreading infection had extended upward and involved the entire forearm and the left foot had become gangrenous. Death occurred shortly after noon May 28.

CASE 31. R. S. Passavant Memorial Hospital, 13313. May 6-9, 1933.

This patient a 22 year old worker in an automobile assembling plant, sustained a number of small superficial slit like cuts on the lateral aspect of the distal phalanx of the left index finger about February 27th. Iodine was applied over the cuts and no further attention paid to the injury. March 2, 3 days later while at work he had several severe chills and on coming home in the evening complained of generalized aching pain, headache and weakness. A physician who was called found the patient's temperature 103 degrees, his pulse 110. He noted two small superficial cuts on the left index finger and an area of localized tenderness in the left axilla. Otherwise the physical examination was negative.

From March 2 to March 5 the patient was treated at his home under a diagnosis of influenza. On the evening of March 5 swelling and redness appeared over the left side of the chest and the left side of the neck, and the physician then realized that the patient was suffering from an extensive spreading cellulitis secondary to an infection beginning in the left index finger.

On admission to the hospital on the service of Dr. Michael Mason at noon, March 6 the patient was obviously very ill. His temperature was 104 degrees, his pulse 134, his leucocyte count 8,300. A wide spread area of cellulitis was present involving the left shoulder, left axilla, the left side of the neck, and the left side of the chest as far down as the waist. This entire area was red, swollen and indurated, with no indication of localization at any point.

In spite of massive warm wet dressings and forced administration of fluids the patient's condition grew steadily worse. The area of inflammation continued to extend upward, downward, and anteriorly over the chest wall and he died shortly after midnight March 8, 60 hours after his admission to the hospital.

At autopsy, shortly after death, it was noted that the swelling had reached the level of the left ear above and the level of the trochanter below. It extended to the midline of the chest at the level of the nipple 4 to 5 centimeters beyond the posterior axillary line at the level of the axilla, and as far down the arm as the insertion of the deltoid. On dissection of the left axilla and left side of the neck the sub-

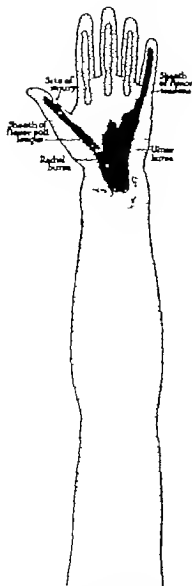


Fig. Case 24. Diagram showing site of injury and extension of infection. Stippled area indicates extent of intense inflammatory reaction; solid black area, site of abscess formation.

cutaneous tissues and intermuscular spaces were found everywhere infiltrated with thin, grayish, turbid fluid which subsequently on culture showed a pure growth of a hemolytic streptococcus. The other anatomical findings were those of an acute septicemia (hemorrhagic serofibrinous pleurisy, acute splenitis, petechial hemorrhages in renal pelvis and under pericardium and pleura, cloudy swelling of myocardium, liver and kidneys).

CASE 32. C. D. B. Cook County Hospital, 1263061. December 27-30, 1931.

This patient, a laborer of 40 years, was seriously ill when admitted to the hospital the evening of December 27. His temperature was 103 degrees, his pulse 120. He was irrational and unable to give an account of his trouble. His son stated that the patient had sustained a slight injury over the dorsum of the left hand a few days before December 31. In spite of local applications the hand and forearm became swollen and inflamed. On December 31 the swelling had reached the elbow and the patient's temperature 103 degrees. December 32 he became irrational and about the same time jaundice of the skin and sclera was noted. He was seen by a physician daily until December 33, on that day sugar was found in the urine, and the physician advised hospital care.

On admission to the hospital the entire left upper extremity above the hand was greatly swollen and inflamed. Although the hand itself was still swollen other inflammatory signs had practically subsided, over the dorsum of the middle metacarpophalangeal joint was the thickened scar of the original injury. The patient was feverish, deeply jaundiced, and stuporous. Addition of 30 drops of urine did not cause reduction of Fehling's solution, but the test for acetone was positive.

A massive warm wet dressing was applied to the entire left upper extremity; fluids were given in maximum amounts and glucose intravenously. These therapeutic measures were entirely without helpful effect; the patient became increasingly stuporous and the jaundice more intense. The acute inflammatory process continued to extend over the shoulder and left side of the body and the patient died 31 hours after admission.

These 10 cases constitute practically one third of the cases reported in this paper and one fifth of the cases observed if the less serious cases in which an acute spreading infection which subsided rather promptly (within from 2 to 10 days) and without localization or abscess formation are included.

In 7 of these cases symptoms of spreading infection developed within an average of less than 19 hours from the time of injury. Death occurred 8.5 days after the injury. In 3 cases (Nos. 23 and 31) an injury occurred several days before the onset of symptoms. In Case 23 a second definite injury was followed by development of symptoms of infection in less than 24 hours, and by death 54 hours after the second injury. In Case 31 there was not a definite history of a second injury but no evidence of infection followed until 3 days after the original injuries then within 5 or 6 hours symptoms of spreading



Fig 12 a



Fig 12 b



Fig 12 c



Fig 12 d

Fig 12 Case 14. Acute spreading infection following injury of volar surface of thumb with subsequent extension into tendon sheath of flexor pollicis longus, radial bursa, common flexor sheath, ulnar bursa, and sheath of flexor tendons of little finger. a, b, c Appearance of hand just before operation 14 days after injury. Note swelling and edema of dorsum of hand and wrist, and swelling of forearm just above anterior annular ligament. d Appearance immediately after operation. Note incision for drainage of ulnar bursa in palm and bulging at ulnar side of wrist just anterior to site of incision for drainage of retro-flexor space in forearm. Because of position of hand incisions for drainage of sheath of flexor pollicis longus and of flexor tendons of little finger cannot be seen.

Fig 13 Case 14. Appearance of hand 6 weeks after operation. Note areas over which superficial necrosis was present (Fig 12) are completely healed.



Fig 13 a



Fig 13 b



Fig 13 c



Fig 14 a



Fig 14 b



Fig 14 c



Fig 14 d



Fig 14 e

Fig 14. Case 14. Degree of function present 9 months after operation

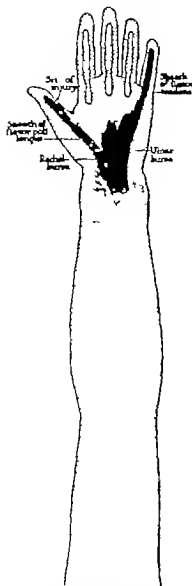


Fig. 14. Case 34. Diagram showing site of injury and extension of infection. Stippled area indicates extent of intense inflammatory reaction; solid black, site of abscess formation.

cutaneous tissues and intermuscular spaces were found everywhere infiltrated with thin, grayish, turbid fluid which subsequently on culture showed a pure growth of a hemolytic streptococcus. The other anatomical findings were those of an acute septicemia (haemorrhagic serofibrinous pleurisy, acute splenitis, petechial haemorrhages in renal pelvis and under pericardium and pleura, cloudy swelling of myocardium, liver and kidneys).

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On admission to the hospital the entire left upper extremity above the hand was greatly swollen and inflamed. Although the hand itself was still swollen other inflammatory signs had practically subsided, over the dorsum of the middle metacarpophalangeal joint was the thickened scar of the original injury. The patient was feverish, deeply jaundiced, and stuporous. Addition of 30 drops of urine did not cause reduction of Fehling's solution, but the test for acetone was positive.

A massive warm wet dressing was applied to the entire left upper extremity; fluids were given in maximum amounts and glucose intravenously. These therapeutic measures were entirely without helpful effect; the patient became increasingly stuporous and the jaundice more intense. The acute inflammatory process continued to extend over the shoulder and left side of the body and the patient died 51 hours after admission.

These 10 cases constitute practically one-third of the cases reported in this paper and one fifth of the cases observed, if the less serious cases in which an acute spreading infection which subsided rather promptly (within from 2 to 10 days) and without localization or abscess formation are included.

In 7 of these cases symptoms of spreading infection developed within an average of less than 19 hours from the time of injury. Death occurred 8.5 days after the injury. In 2 cases (Nos. 23 and 31) an injury occurred several days before the onset of symptoms. In Case 23 a second definite injury was followed by development of symptoms of infection in less than 24 hours, and by death 54 hours after the second injury. In Case 31 there was not a definite history of a second injury but no evidence of infection followed until 3 days after the original injuries; then within 5 or 6 hours symptoms of spreading

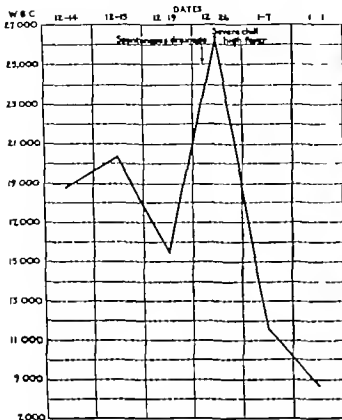


Fig. 16. Case 17. Graph showing variation in leucocyte count during stage of acute infection.

A forceful argument in favor of this contention has recently been added by the experimental work of Hudack and McMaster in demonstrating the rapidity of diffusion of dyes through the lymphatics of the living skin. With the aid of the binocular microscope and photographs (Fig. 22) made with a microcinema camera these workers found that within 30 seconds after beginning an intradermal injection 'the plexus of lymphatics showed dye over an area 14 to 15 millimeters in diameter and in 45 seconds the colored plexus was 2.5 centimeters wide. Within 1 minute and 15 seconds the outlines of the vessels first entered became blurred by dye that had escaped secondarily from them into the interstitial spaces through the lymphatic wall.

Many experiments led them to conclude 'that all slight breaks in the physical barrier of the skin yield opportunity for the passage of dissolved foreign matter into the skin lymphatics, and that the slightest penetration beneath the epithelium opens these vessels to the entrance of particulate matter

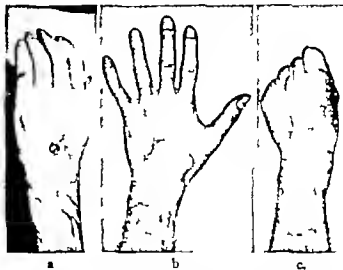


Fig. 17. Case 17. Acute spreading infection following knife cut of dorsum of little finger with eventual localization and abscess formation over dorsum of metacarpus. a. Appearance of hand 13 days after localization of infection and spontaneous drainage. b. c. Appearance of hand 355 years afterward.

Further these workers found that, "5 minutes after the injection dye can usually be seen 15 centimeters away from the injection spot in the draining lymphatic trunks rendering visible those which lie in the subcutaneous fat. In two instances dye has been perceptible in the draining trunks of the axillary portion of the arm 8 minutes after an intradermal injection of 0.10 cubic centimeter of patent blue V into the volar surface of the forearm." In another case dye could be seen in the lymphatics almost as high as the axilla 6 minutes after an injection into the volar surface of the forearm.

Further studies were made by Hudack and McMaster with intradermal injections of toxins to which dye solution had been added in a ratio of 1 part to 20 or to 10 parts of toxin. In these cases the injected material entered the lymphatic capillaries and passed along the anastomosing channels just as did the dye solution.

In view of all these facts it is impossible to believe that even if one could visualize an infected wound tract perfectly he could sterilize it with a cautery or with chemical reagents simply because of the rapidity with which infected material is carried along the lymphatic channels and away from the site of injury. Until it is possible to develop methods of identifying bacterial types and strains with



Fig. 19. Case 30. Result 4 months after healing of incisions made for drainage of a widespread suppurative process involving entire dorsum of hand, forearm, and lower half of arm. (See frontispiece.)

rapidity and certainty and of obtaining specific antitoxins for them our best resource in treating patients with such injuries lies in helping to insure the efficient working of the method nature has used for many centuries in combating infection namely rest mobilization of the resistant parts of the body by production of an active hyperemia and elimination.

Once evidence of rapidly spreading infection has developed the un wisdom of attempting to arrest it by active surgical treatment has been amply demonstrated. The increased permeability of the lymphatics after slight injury as from ultraviolet light or after inflammatory change demonstrated by Huddack and McMaster in the experiments referred to furnishes a very logical explanation of this frequently observed clinical fact. Only 1 case of those reported (No. 2) in which operation was carried out early during the period of active extension of infection survived and this patient in our judgment survived in spite of the operation. On the other hand when conservative treatment was carried out until there was positive and unequivocal evidence of localization of infection (cases in groups 2 and 3) recovery almost always took place rather rapidly after drainage of the localized infection had been instituted.

Finally it has often been said and we believe with unanswerable logic, that every infected wound should be treated with the same scrupulous care with reference to asepsis that is accorded the clean case in the operating room. Only in this way can the addition of new and different strains of bacteria be avoided and the patient saved from an added infection to which he may have little or no immunity or from an infection which in symbiosis with that which is already present may prove particularly harmful. In this connection it is of interest that one patient (No. 13) whose original injury was a cutting wound so slight that it did not bleed stated that after the thumb was incised the hand with its open draining wound was soaked four times daily in an arm bath which was not sterilized so far as she knew and in which the solution was reheated before the soaking several times a day without being changed. The pus evacuated from the retroflexor space of this patient on culture showed a heavy growth of both a hemolytic streptococcus and bacillus pyocyaneus, and a few colonies of Staphylococcus aureus. It seems entirely logical to think that this mixed infection was an important factor in contributing to the seriousness and duration of her illness and to the ultimate destruction of the tendon in the infected sheath.

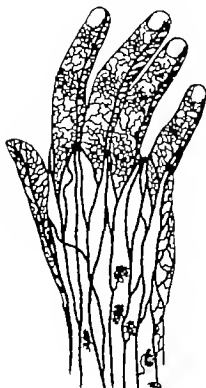


Fig. 20 The closely lying lymphatics of the dorsum of the hand, and the anastomosing collecting trunks (from Kanavel and Mason, *The Cyclopaedia of Medicine* vol vi)

BACTERIOLOGICAL FINDINGS

The term streptococcic septicaemia so often applied to the types of cases under discussion is not a misnomer. Of the 2 cases in group 1 1 patient was infected while transferring a culture of a haemolytic streptococcus. Of the 5 patients in group 2 with axillary localization in the most serious case (No 6) a pure growth of a haemolytic streptococcus was repeatedly found in the cultures made from pus evacuated from the localized abscesses. In 2 other cases a non haemolytic streptococcus was found in pure culture. In a fourth case a colon bacillus and a few colonies of staphylococci. In the fifth case (No 5) although the clinical picture and the widespread scarlatina-like eruption followed by generalized desquamation (Fig 1) were characteristic of a streptococcic infection only *Staphylococcus aureus* was found in the superficial axillary abscess which was incised some weeks later.

Of the 15 cases in group 3 a pure culture of a haemolytic streptococcus was obtained from the pus evacuated in 6 cases in 3 other cases a haemolytic streptococcus was recovered in conjunction with *Bacillus pyocyaneus* in 1

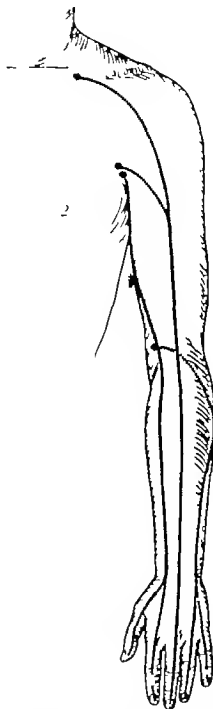


Fig. 21 The main lymphatic trunks of the forearm and arm. Note the direct pathway from the middle finger to the supraclavicular region (from Kanavel and Mason, *The Cyclopaedia of Medicine* vol vi)

case with a haemolytic staphylococcus in another case and with a non haemolytic staphylococcus in a third case. In 1 case a pure culture of a *Streptococcus viridans* was recovered and in another a pure culture of a non haemolytic streptococcus. In 4 of the 15 cases in group 3 the bacteriological findings were not available.



Fig. 32. Successive stages in the distribution of dye during injection of the skin. An 11 per cent solution of patent blue V was injected intradermally and a cinematographic record made of the spread of the solution. The figures here shown were selected from the film to show the course of events. The injection of 0.2 cubic centimeter required 80 to 85 seconds. a, Beginning of injection; b, 30 seconds after beginning injection; c, 45 seconds after beginning injection; d, 1 minute and 15 seconds after beginning injection; e, 30 seconds after completion of injection. Area in b is 14 to 15 millimeters, in c is 2.5 centimeters. $\times 1.5$ (From Hodack and McMaster *J. Exper. Med.* 1933, of Ives Plate 46.)

In 1 of the 10 fatal cases (No. 24) a hemolytic staphylococcus was obtained from the serum of a blister that had formed at the site of the original puncture wound. A culture made from the blood of the same patient 19 hours before death remained sterile after a number of days incubation. In a second case (No. 25) a hemolytic streptococcus was obtained from the serum of a blister that had formed at the site of the original puncture wound. In a third case (No. 28) a short chained streptococcus was recovered from the blood taken 5 days after the injury and onset of symptoms. This is the only case of the entire series in which a positive blood culture was obtained. In a fourth case (No. 31) a hemolytic streptococcus was recovered in pure culture from the pus obtained at autopsy from the subcutaneous tissues of the chest wall and axilla.

LATE COMPLICATIONS

We are accustomed to think of involvement of the serous membranes—joint inflammation, endocarditis, pericarditis, etc. of myocarditis and vascular disease as possible sequelae of the streptococemia of scarlet fever and of other infections, particularly epidemic infections. We are likely however to forget that such sequelae can also follow an acute streptococcal infection of the hand and forearm and that it behooves us to keep this possibility in mind both in suggesting the proper treatment and in making a prognosis.

The history of one patient subsequent to his infection is of sufficient importance to report the details.

This patient, reported as No. 1 in group 1, returned to his work at a research laboratory one week after the subsidence of his symptoms and after his dismissal from the hospital. On March 28, 18 days after leaving the hospital, he first noticed slight irritation of the right eye and a few red striations running outward from the iris. During the next week he noticed marked lacrymation and gradually diminishing vision. By April 6 vision in the right eye was almost gone.

From April 7 to May 7 he was under constant treatment with hot wet dressings over the eye and local administration of atropine.

On May 7 he was admitted to Wesley Memorial Hospital on the service of Dr P D O Connor and Dr J H Hutton complaining in addition to the loss of vision in his right eye, of pain in both shoulders, both ankles, the left wrist and thumb, symptoms which had appeared subsequent to the development of the chorioretinitis.

On May 18 a presystolic roughening was heard for the first time along the left border of the sternum. Two days later he had a chill after which the pain in the joints was much worse, although no redness or other evidence of localised infection could be elicited. For a number of weeks low grade fever, tachycardia, and moderate irregularity of the pulse on slight exertion were persistently present. During this period he had several acute attacks of precordial pain associated with tachycardia weakness, and almost complete disappearance of the pulse at the wrist.

In the latter half of June he began gradually to improve, the pain in the joints disappeared and he was able to sit up in bed for an hour twice daily with little increase in the pulse rate.

On September 13 it was noted by Dr O Connor. The right fundus is somewhat hazy due to vitreous opacities. Temporal to the disc is an area of old choroidal atrophy with a pigmented border. Nasal to and above the disc is a bluish white area with indefinite borders which is probably the site of the active lesion. The left fundus shows a small healed lesion above the disc.

The following day the patient was dismissed from the hospital and eventually returned to his work, but with marked impairment of vision and of physical strength.

The development of a short rough apical systolic murmur during the course of her infection in the patient reported as Case 18 and of definite symptoms of myocardial damage in the patient reported as Case 10 have already been told. The patient reported as Case 8 developed mild anginal attacks during the years immediately following his infection but paid little attention to them. June 4 1934 he developed an acute attack of coronary thrombosis and died after an illness of less than 48 hours duration. The patient reported as Case 7 developed a marked psychosis 2½ years after his infection and is now under treatment in a private sanitarium for mental diseases.

These rather fragmentary reports, in spite of their incompleteness help to emphasize the fact that acute infectious myocarditis endocarditis, and vascular disease are quite as likely to follow an acute streptococcal infection which follows a trivial injury of the hand

as they are to follow the streptococcus infection associated with the acute contagious diseases or that group of milder infections involving the upper respiratory tract which as Carr and Walsh have recently pointed out so frequently lead to acute infectious myocarditis.

SUMMARY

Thirty two cases of acute spreading infection are reported all of which developed rather rapidly after trivial injuries and in the majority of which the outstanding symptom early in the course of the infection was the presence of red lines of extension along the lymphatic channels leading upward toward the axilla.

In 2 of these cases the inflammatory process subsided rather promptly and without localization and abscess formation.

In 5 cases the symptoms at the original site of injury disappeared rather quickly, but marked axillary lymphadenitis developed and subsequently abscess formation in the axillary supraclavicular or subpectoral regions.

In 15 cases the inflammatory process extended upward rapidly at first, then more slowly and finally came to a halt, usually at a level between the elbow and shoulder. After a varying interval the process began to recede and eventually abscess formation took place. In the 7 cases in which the original injury was on the volar surface of the hand the abscess formation involved one or more of the synovial lined spaces (the tendon sheaths or bursa). In 4 of 8 cases in which the original injury was on the dorsum of the hand eventual localization occurred over the dorsum of the meta carpus, in the 4 others after a varying interval of time almost the entire area of inflammatory induration over hand, forearm and arm underwent liquefaction within a relatively brief period, with resulting abscess formation involving the subcutaneous tissues over an extensive area.

Nine patients, among them 2 physicians and 2 nurses, died after intervals of from 4 to 13 days after the original injury. One patient succumbed to a bilateral bronchopneumonia 35 days after the injury.

Of 20 cases in which bacteriological findings were available a hemolytic streptococcus in

pure culture was recovered in 10 cases, a hemolytic streptococcus in symbiosis with other organisms in 3 cases, a non hemolytic streptococcus in 4 cases, a *Streptococcus viridans* in 1 case and a hemolytic staphylococcus in 1 case.

In 5 cases definite postoperative complications developed subsequent to recovery from the acute infection and in 4 of these the complications were attributed directly to the antecedent infection.

Of the 22 patients who recovered all were treated conservatively from the moment they were first seen with rest in bed massive warm wet sterile dressings over the entire

upper extremity and forced administration of fluids and in none was the inflammatory process incised until absolute evidence of localization and abscess formation was present.

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THE DIEFFENBACH-WARREN OPERATION FOR CLOSURE OF THE CONGENITALLY CLEFT PALATE¹

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THIS operation is commonly called after Bernard R. K. von Langenbeck but as it is a fundamental contribution it might seem fitting that it recall two men who rather simultaneously worked out and put in to execution a successful plan for closing congenital palate clefts that has never been superseded and as far as known history records was basically original.² There have been modifications or substitute plans but as a class these are more difficult of execution and with the exception of the "push back" type which in this country has been developed by Dorrance as a rule show less regard for normal anatomical arrangement or for possible serious damage to developing bones and teeth.³

While hygiene of the mouth nose and middle ear, and the later facilitation of dental prosthetics should be sufficient reasons for the closure of the open palate cleft, the driving motive for the operation is the desire to improve the faulty speech. In its last analysis, the modifications and interruptions of the vocal sounds essential to enunciation are just as dependent upon muscle action as is the act of walking. An inert dental prosthesis, or a repair from live extraneous or passive tissues can be made to supplement a deficient palate just as walking can be aided by an artificial limb but to function each requires that it be under some indirect muscle control.

While the common designation mentions only the cleft such a palate is usually short anteroposteriorly and without sufficient compensating hypertrophy of its essential muscles to control the air leakage. Clinical evidence of a prevalent muscular deficiency comes from

the occasional case in which there is normal speech with a wide open cleft, together with the fact that in the majority of cases, enunciation can be improved still further by speech training subsequent to closure of the cleft. Chalmers Lyons is gathering confirmatory laboratory evidence. Judged by the relatively late period at which the average cleft palate child attempts to talk a muscle deficiency and also the open cleft might primarily be dependent upon some derangement or blight in the nervous mechanism just as marked congenital deficiencies of the external ear are frequently an expression of a blight somewhere in the auditory tract or its connections.

The greatest adjuvant to the short passive palate is a muscle band in the upper part of the superior pharyngeal constrictor, which can act as a half purse-string in closing off the nasopharynx. With a deficient palate over action of this strand may draw forward a thin shelf like fold of mucosa commonly called Passavant's pad and the degree to which this plica is developed before operation can be taken as a rough indication as to quality of the postoperative speech results. This necessity for developing the crippled musculature in no way minimizes the indications for proper operative closure but emphasizes the importance of not further hampering the already deficient muscle power.

Even when the operative procedure is technically correct which presupposes preservation of an adequate blood supply, sufficient mobilization without damage to essential structures and proper coaptation of the denuded borders complete or partial failure may be a not uncommon result either from lack of primary union or lack of good function. Granting all of the above failure of union is almost always due to infection and its occurrence can be lessened chiefly by control of local foci by having the patient in good condition, by avoiding periods of prevalent respiratory infections or the exanthemata

¹The operation of bridging the cleft of the hard and soft palate by means of mucoperiosteal flaps raised from the inner surface of the hard palate through lateral incisions, mobilizing the two halves of the cleft by dividing the palate aponeurosis with its overlying nasal mucosa and then freshening and suturing the borders of these flaps, was first described and named by Dieffenbach (1828). Warren reported several cases in which operation was done by the same general plan but the lateral incisions were omitted. Mactetter in 1874 reported a operation on the hard and soft palate apparently using lateral incisions (1).

²The "push back" operation is applicable only to partial clefts and may be indicated only when the palate is particularly short.



Fig. 1

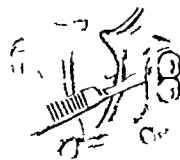


Fig. 2



Fig. 3



Fig. 4

Fig. 1. Accurate but distorted representation of an exact left sided single complete cleft of the palate in which the alveolar borders have been approximated and the anterior part of the palate cleft has been narrowed by pressure of the lip and cheeks as the result of the closure of

the lip cleft some months previously. The distortion mentioned is not of any particular structure but in the relationship of the two component halves to each other. For the better display of the subsequent sequential steps and at the same time to accentuate the relation of each member to the palate as a whole in the box illustration each is represented as if viewed along an axis more nearly vertical to the palate process than to the palate as a whole. That is, as if each half were viewed individually. This gives an open cleft appearance with greater transverse width than is normal.

Fig. 2. Mobilization—Dieffenbach's approach. As here presented, the first and the characteristic step of the Dieffenbach operation is a lateral incision through the mucoperiosteum down to the bone in the molar region, which, when extended behind the maxillary tubercle, severs the continuity between the lateral border of the soft palate and anterior fascial pillar from the buccal mucosa. The knife being held oblique to the sagittal plane, its point contacts with the alveolar bone just above the necks of the teeth. The line of the incision is along the base of the gingivae, the fringe itself and its relation to the necks of the teeth being undisturbed. The point of the knife scratches along the bony surface of the alveolar process touching neither the necks nor crowns of the teeth and avoiding the trunk of the major palatine artery by a wide margin. All of the soft tissues down to the bone are cut as the blade is pushed backward, the line of the cut curving outward between the maxillary tubercle and the hamular process. Behind the hamular process, the axis of the knife handle shifts to more nearly parallel the sagittal plane, the blade cutting deeply in the direction of the pterygomandibular

ligament, the point being kept median to the anterior border of the mandible. The exact position of this cut, both on the surface and in its depth, should be first visualized and then accurately made with one purposeful stroke.

Fig. 3. Mobilization—Warren's approach. On the undistorted side where the nasal septum becomes continuous with the palate process, time and tissue will both be saved by making an incision through the septal mucosa parallel and close to its junction with the palate tissue. If the palate cleft were usually wide in its anterior part, more of the nasal mucoperichondrium might be included in the palate flap but this is seldom necessary in single clefts and is not practicable in double clefts. The extreme anterior part of this incision is sometimes made by inserting a small blade through the nostril on the cleft side or with the cutting edge of a sharpened Brophy elevator, but, for the present, that much of the incision as here indicated will suffice.

Fig. 4. Mobilization—elevation of the mucoperiosteal flaps. The point of the angle elevator enters the lateral incision just in front of the post-palatal foramen and then by slight rotary movements of the shaft and by picking up the periosteum from the palate process, the point is worked toward the mid-plane until it pierces through the line of incision at the base of the nasal septum and protrudes into the cleft. By changing the angle at which the shaft is held, and working a bit forward, the mucoperiosteum, and, with it, the posterior palatine artery can be freed from the underlying bone as far forward as the incisor foramen. The artery in its course forward, may be deeply embedded in a groove on the under-surface of the palate process, from which it is to be dislodged by working the point close to the bone.

Figs. 5, 6, and 7. Mobilization—major palatine artery. Figures 5, 6, and 7 are diagrammatic representations of a transverse section through the maxilla made just posterior to the contents of the descending palatine canal viewed from behind. Figure 5 shows the point of the elevator but as it first enters the lateral incision near the posterior border of the hard palate. In Figure 6 the point of the elevator has been pushed palato-ward encountering the palate process. By rotation of the shaft, the point of the bit can be made to raise the submucous part of the artery.

In the original Warren description, the elevation of the mucoperiosteal flap is done from the cleft border; the elevator working laterally toward the base of the alveolar process. Some advocates of the Dieffenbach operation have criticized this lateral incision on the theory that it necessarily severs cutaneous nerves and vessels. Such criticism can be properly made only through a lack of understanding of its purpose and of the related anatomical structures. It not only can be made without creating any essential structure but allows the greatest relaxation of the palate tissue with less risk to the major palatine artery and permits of subsequent fixation and hemorrhage control, by lateral pressure.



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10.

out of the posterior end of its groove. Figure 7 shows the relation of the elevator bit to the palate tissues, the artery and the bone, just as the point of the elevator bit is about to emerge into the cleft (Fig. 4).

Fig. 8. Mobilization—elevation of the mucoperiosteal flaps. Having completed the elevation of the mucoperiosteal flap from the palate process, the angle elevator is next inserted into the lateral incision between the hamular process and the maxillary tubercle, well behind the trunk of the palatine artery. The shaft is then rotated and the bit, passing behind the base of the hamular process, is pushed toward the median plane, tunneling a path that parallels and somewhat approximates the posterior border of the palate process.

Fig. 9. Mobilization—elevation of the mucoperiosteal flaps. Using the point as a fulcrum, the shaft is rotated so as to swing the heel of the instrument toward the mid plane the velum tissues being forcefully pushed in that direction.

Fig. 10. Mobilization—elevation of the mucoperiosteal flaps. The palate flap consisting of the mucoperiosteal covering of the hard palate in front and of the velum and fauces behind, have now been fairly well freed laterally both anteriorly and posteriorly but are still bound to the alveolus by some firm tissue just median to the maxillary tubercle. This might be dissected free with a knife but more safely by stretching it with the heel of the angle elevator.

Between the posterior palatine foramen and the point at which the artery enters the substance of the mucoperiosteal covering of the palate bone for a distance of some 3 to 5 millimeters, its trunk traverses the plane between the hard and the soft tissues and lies somewhat free and enveloped in loose connective tissue. It is this anatomical

arrangement that permits the palate flaps to be shifted bodily inward and still preserve the blood supply. Retaining this blood supply at least doubles the chances of a successful closure. To do this, the bit of the elevator is reinserted so that it lies just within the anterior part of the incision its heel approximating the maxillary tubercle and the point lying along the base of the alveolus.

Fig. 11. Mobilization—elevation of the mucoperiosteal flaps. A rotation of the elevator as described under Figure 9 is now repeated. The procedure thus far depicted should be carried out on one side in a few minutes and our observations have led to the belief that speed tends greatly to lessen the essential risks of this operation. The above is likely accompanied by quite a bit of bleeding, which, if too severe, can be controlled at any stage by finger pressure with a gauze pad on the palate tissues. If, however, the main artery is not cut or torn, one can usually go through to completion and then control bleeding by packing the wound.

Fig. 12. Hemostasis. The bleeding is now controlled by packing. This is done with a strip of gauze 4 to 6 folds thick, 2 centimeters to 3 centimeters wide and 3.5 to 5 centimeters long. One end is forced deep into the velar tissues, filling the posterior half of the lateral incision by means of the curved-on-the-flat elevator.

Fig. 13. Hemostasis. About half of the strip having been disposed of as shown in Figure 12 the other end of the strip is passed under the mucoperiosteal palate flap in front of the descending palatine artery and the remaining loop of pack is stuffed into the incision external to the trunk of the artery.

Fig. 14. Mobilization—division of the palate aponeurosis. This may be done either with a curved scissor or a small sharp scalpel the latter is the more accurate method



Fig. 3



Fig. 12



Fig. 5

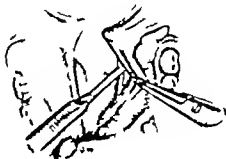


Fig. 4

but the former may be more applicable to clefts extending but a little way forward from the alveolus. Inserting a sharp hook or the needle-pointed puller into the free median edge of the liberated palate flap, drawing the latter toward you, the tenaculum aponeurosis and the mucosa covering its nasal surface, are cut with the knife point along the posterior border of the palate process as far as one can see, which may be but a few millimeters on the first hold. Catching the palate edge farther back, at each knife stroke as the flap becomes freer, more of the field continuously comes into view.

In this way one can extend the incision back to the Eustachian cushion if need be, with the actual field of incision always in view. If in the lateral pharyngeal wall, one cuts a fairly sized artery it is caught with a heavy crushing Ochsner and, if practicable, tied with a simple ligature or suture on a curved needle. This bleeding, however, usually can be controlled after crushing the vessel, by rearranging the lateral packing so that the posterior end of the folded gauze extends into the nasopharynx just enough to rest within this lateral incision in the nasopharyngeal wall. Whether the simple cutting of the aponeurosis and nasal mucosa along the posterior border of the palate bone gives sufficient relaxation or how far the cut must be extended along the lateral nasopharyngeal wall, is determined by repeatedly testing the relaxation with the needle-pointed puller (see Fig. 7).

Fig. 5 Mobilization—division of palate aponeurosis. The elevation of the posterior part of the palate flap having been completed on one side and bleeding controlled, it is repeated on the other and the free median border of each flap is now examined. If the division of the palate from the nasal mucosa has not been completed to the posterior end

of the palate process, whatever remains of this connection is divided with the point of the knife. This separation should go right to, but should not split, the velum.

Cutting the attachment of the palate aponeurosis and of the superimposed nasal mucosa along the posterior border of the palate process is the next essential step. This will complete the mobilization of the macroposterior velar flap, allowing it to drop back toward the pharynx, downward toward the tongue, and median toward its fellow of the opposite side as shown in the cross section (Spalteholz).

In relatively narrow clefts, the cutting of the palate aponeurosis from the posterior border of the palate process and with it the mucosa covering its nasal surface is sufficient. In wide clefts this incision is usually extended laterally to the nasopharyngeal wall, and backward in its course toward the Eustachian cushion, and may even include some of the fibers of the levator palati muscle before sufficient relaxation is obtained.

Fig. 6 Mobilization—division of palate aponeurosis. In partial clefts, the extensive freeing described under the preceding figure will not be necessary and it will be found more convenient to divide the aponeurosis with curved scissors on account of the limitation of the field of vision.

Fig. 7 Mobilization—testing posteriorly. If the junction of the velum with the mucocutaneous flap can be easily brought across the midline to meet its opposite, the latter lying in its natural position, then this part of the flap is sufficiently free.

Fig. 8 Mobilization—division of the posterior faucal pillars. Reinserting the needle-pointed puller just proximal to the base of the uvula, the same test is repeated. If the posterior part of the velum is not sufficiently free, one further observes to determine if it is the resistance in the



Fig. 15

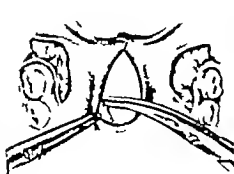


Fig. 16



Fig. 17



Fig. 18



Fig. 19

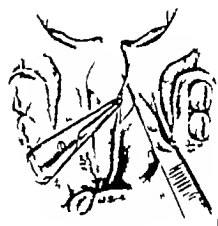


Fig. 20

anterior or posterior pillar. The former may be released by extending the original lateral incision further backward or a tense posterior pillar is cut at its attachment to the pharyngeal wall with the knife or scissors, first putting it on tension with the needle pointed puller as shown in Figure 18. If the cut is made close to the pharyngeal wall, very little of the palatopharyngeus muscle will be severed from its nerve supply and subsequent scarring will repair the defect in the pillar. Any arterial bleeding should be controlled before proceeding further and this is best done with a suture of a double plain catgut strand on a palate shaped strong needle. The double strand will preclude loss of the needle in the tissues, should struggling occur at the time of its insertion. If so far things have gone well and the child is in good condition one may proceed to free the mucoperiosteal flaps at the anterior end of the cleft. To facilitate the suturing in this part, this freeing should extend to the edge of the gum or to the incisor gum fringe and a short, somewhat transverse cut on each side, vertical to the cleft, may be of great help (See Fig. 19).

Fig. 19. Mobilization—elevation of mucoperiosteal flap. Usually this is most easily accomplished with a sharp edged Brophy elevator with which one can divide the connection between the palate and the nasal mucosa and also raise the flap from the underlying bone. In freeing the median edge of the flap that covers the premaxilla, difficulty is encountered in the neighborhood of the incisive foramen. It may be of some help to insert the small knife through the nostril or to use the curved-end-of-the-flap elevator. We have ceased to do a palate repair on children under a year old and by that time the incisor teeth are usually erupted but

it is to be remembered in using the Brophy elevator in this region that, if the mucoperiosteum is raised from over the bud of an erupting tooth, it may interfere with its further development. If however after freeing the flaps at their nasopharyngeal attachments, there is a tendency for bleeding to persist or if there is any other suggestion that it might be well to curtail the operation one may now advantageously disregard the anterior part of the cleft and proceed at once to denude and suture the posterior part that has already been mobilized. After this suturing has been completed the anterior part of the cleft may then be sutured or it may be deferred to some future time as the patient's condition dictates. Also if either major palatine artery has been damaged, one should be very cautious about cutting around the anterior end of the flap of the damaged side as some necessary blood supply or return might in this way be sacrificed.

Fig. 20. Denudation—of the cleft border by paring. The classic plan of freshening the cleft borders of the velum and uvula for suture is to cut off a thin ribbon of mucosa but this is ordinarily an unnecessary sacrifice of tissue in an area already deficient, and we now resort to it only under one of three conditions: (a) when there is some reason to complete the operation in the shortest possible time. (b) when there is some special difficulty in getting at the field of operation. (c) in cases of two stage or secondary operation after a previous failure where the cleft borders are puckered with hard scar.

¹Logan has shown that the buds of the premolar teeth lie in the soft tissues of the palate just medial to deciduous molars where they might be damaged easily either by injudicious use of the knife or elevator.

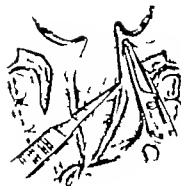


Fig. 2



Fig. 22



Fig. 23



Fig. 24

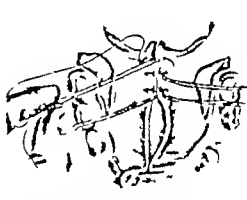


Fig. 5

Fig. 2. Denudation—of the cleft borders by splitting. In a primary operation, where the velum is accessible and where conditions are satisfactory, we follow the plan used by Lyons, of splitting the mucosa of the border of the alveolus and uvula, and also of the posterior pillars if these latter are to be sutured (see Fig. 22).

The border of the velum is split deep enough to allow sufficient eversion of the edges to give a raw surface equal to its thickness. The cut will be a little deeper anteriorly than in the center and only the mucosa is divided at the uvula. The under surface of the base of the uvula is caught with the pusher as shown, or the base of the velum is engaged with the puller and the free border is split with a bistoury or a special knife. In this way the depth of the cut can be judged and controlled with considerable accuracy. As one cuts farther back, the pusher can be substituted for the puller. When things go nicely this cut may be completed with one movement, the knife gradually paralleling the tense border of the alveolus and smoothly splitting the mucosa as it is pushed back toward the apex of the uvula. On the other hand, it may prove to be a catch-as-catch-can performance, and one transfixes the alveolus to push or pull in any way that best serves.

Whether done by panning or splitting, both borders are examined throughout their full extent to see that everywhere they present sufficiently broad, cleanly cut, raw surfaces which can be easily approximated by the sutures. Much time will be lost and union may be compromised by attempting to unite ill-fitting parts. Any place in the velum where the mucous edge is rough or unmanageable can be

radically undercut or pared. The area near the palate aponeurosis is particularly important. The borders of the mucoposterior flaps from the hard palate should first be examined with the rounded point of an artery forceps, for any spicules of bone that might have been included with the flap and any such should be removed. Next, any ragged edges should be trimmed and one should be able to evert the edge of the flap toward the mouth even in its anterior extremity.

Fig. 22. Denudation—splitting the posterior faucal pillars. In those past infancy the palate can often be conveniently lengthened by continuing the denudation and the suturing to the adjacent parts of the posterior faucal pillars. To do this the anterior half of the border of each is split as shown, the cut being continuous with the alar slit at the base of the uvula, and farther back with the transverse cut in the body of the pillar. It is possible to unite the pillars sufficiently to interfere immediately or subsequently with nasal respiration and this must be borne in mind. Figure 20 shows pillars sutured. When this is done suturing of the nasal surface shown in Figure 23 is omitted.

Fig. 23. Suture—the Key suture. The first suture which, with us, substitutes for any form of supplementary fixation, engages the fibers of the palat aponeurosis on each side. This being of tough fibrous tissue mild infection, or drawing the suture too tightly will not cause it to cut through as quickly as in the softer structures. This type of stay suture is a bit apt to do harm as are lead plates or circumferential tape bands, or any other type of surface pressure.



Fig. 26



Fig. 28

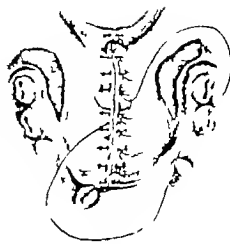


Fig. 29

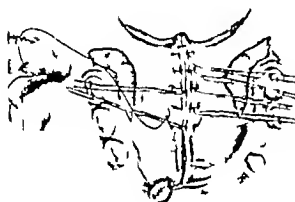


Fig. 27

The left border of the cleft is drawn forward with the puller and the point of a full curved needle enters the raw surface near the oral border at the cut edge of the aponeurosis, digging 4 or 5 millimeters into the substance of the velum to emerge posteriorly nearer the nasopharyngeal border. The right border is then caught with the puller and the needle entering posteriorly near the oral border emerges near the nasopharyngeal border. The knot is tied at the nasopharyngeal surface. Both strands are caught with a light artery forceps (mosquito pattern) 10 or 12 centimeters from the knot and dropped to the left of the patient's face. (See Fig. 24.)

Fig. 24. Suturing—the velum. Starting just behind this first, the aponeurotic suture (5) three or four interrupted vertical mattress sutures are placed in the velum and the mucous edge on each side is in turn caught up with the puller so that the needle will engage just 1 or 2 millimeters of the edge.¹

¹For sutures we use a good quality of "Tive" horse hair both because it comes very little swollen and is, therefore, well tolerated by the tissues, and also, though it has sufficient strength to stand proper handling, it is apt to break if the knots are drawn too tightly. Each is cut 15 to 18 inches long, threaded at the proximal, the thicker end of the hair, tied in the eye with a single knot, and the protruding short end is cut half the length of the handle. There are microscopic scales on a horse hair, these fine end directed distally which make it easier to draw the hair through the tissues root-and-crest. If the hair is too long or too short, it will slip out the knotting. If the short end protrudes too far from the eye it will be in the way. If it is too short it may unite itself. Horse hair becomes untied easily and for this reason at least few knots are put on each suture as follows: the first with post-surgical tension to approximate the raw surfaces closely. The second so as not to disturb the tension of the first, the next two knots are tied with increasing tension so as to prevent straining.

Fig. 25. Suturing—the velum. Then drawing on this loop with the thumb and finger the needle traverses both borders deeply but not deep enough to include any of the mucosa of the pharyngeal surface. Each of these three or four deep sutures, as they are tied are caught with forceps and dropped to the right of the patient's face. One or two simple mucosa sutures are placed on the under surface of the uvula and one in its tip, the free ends of these sutures with the attached forceps being dropped in front of the patient's face. This brings the pharyngeal surface of the uvula and of the velum into view (Fig. 26).

Fig. 26. Suturing—the uvula and upper surface of the velum. One or two mucosa sutures are placed in the pharyngeal surface of the uvula and, if the posterior faucial pillars are not to be united, two or three vertical mattress sutures along the upper surface of the velum.

Fig. 27. Suturing—the mucoperiosteal flaps. If needed the anterior end of the cleft border is now further mobilized. If the artery was damaged on one side one might get by with extending the lateral incision on the sound side all the way forward until it connects with the cleft in front, thus liberating a tongue-shaped flap with its base at the major palatine artery which can then be united to the other side with expectation of primary union. Where both descending palatine arteries are intact one might raise such a tongue-shaped flap on either side and, after uniting along the cleft line, anchor the anterior free end where convenient, with a few simple "tacking" sutures. This is mentioned by Arthur Keith (6) who simply allows the freed flap to hang loose trusting to granulation and scarring to anchor the flap in its proper place to the under surface of the maxilla. With the addition of the "tacking" sutures, this has worked satisfactorily in our hands, but we prefer where possible, to leave, at least, a narrow attachment of uncut tissues anteriorly on one side. On the whole, however if there is any doubt of the integrity of the major palatine arteries, it is safer to suture as far forward as the original relaxation will permit without tension and do the remainder at a subsequent operation as a simple failure of union is much less a catastrophe than a slough or a distorted flap.

The mucoperiosteal palate flaps are united with vertical mattress sutures bringing several millimeters of the raw upper surfaces into contact. It is at the junction of the velum with the mucoperiosteal flaps that one is most apt to have a failure of union due either to insufficient relaxation or deficient blood supply and it is to be remembered that tight suturing interferes with blood supply.

and especially with young infants, by carefully protecting the patient from contamination carried by the operator's breath or from the presence of someone with an acute coryza. That aseptic or antiseptic technique as ordinarily interpreted may have little bearing on the result is suggested by pre Listenan reports of series operated upon with fewer average failures than we can show today (Maetter's series). Of importance is careful handling of the tissues and of the patient; the prevention of excessive loss of blood and of aspiration. The latter is greatly helped by operating with the patient's head hanging over the end of the table (the Rose position) and by suction. It is our belief that there is no post-operative plan of mechanical protection or support of the suture line equal to packing of the lateral incision with strips of gauze. This also helps to control bleeding and splints the palate, but the use of any one of these is not free from added danger either to the patient or the palate.

The most pertinent criticism that can be leveled at the original Dieffenbach-Warren operation is that it fails permanently to lengthen the intrinsically short palate. Brophy attempted to compensate for this by partially uniting the posterior faucial pillars and on the average produced the longest palates that we

have had opportunity to examine. However the posterior part of a palate thus lengthened curves somewhat downward away from the plane of the pharyngeal muscular band mentioned and thus, must work at a mechanical disadvantage. To be of the greatest help the lengthening should be in the plane of Passavant's pad. When at the operation the velum is allowed to drop back by section of the palate aponeurosis, a raw area presents itself on the upper surface of the palate flap appearing from under the posterior border of the hard palate (see Fig. 15). As this heals the velum again assumes its original position. We have attempted to prevent the secondary drawing forward of the velum by covering this raw area with flaps of mucosa turned from the cheek through the lateral incisions. This has given us some quite satisfactory results but on the average the bleeding has been so severe as to cast a doubt on the advisability of the procedure. Veau has varied the original procedure by not cutting the nasal mucosa laterally behind the bony palate but undermining and stretching it without dividing the aponeurosis. The thought occurs that the indications which time may confirm for the more radical "push back" modification will come not simply from the fact that it lengthens the palate but that the lengthening is in

Fig. 8 Suture—mucoperiosteal flap. The most anterior suture is tied with a long strand attached to the needle which latter is temporarily dropped in front of the patient's face.

Returning to the aponeurotic suture that hangs to the patient, left both strands are caught so the tip of a pointed artery forceps is centimeters from the knot, and the suture is just beyond the beak of the hooked forceps is then pushed into the nasopharynx, the jaws are opened to liberate the strands and the forceps is withdrawn. The suture remaining on the pharyngeal surface later to cut its way out. The exact circumstances of its subsequent expulsion we do not know for we have never again heard from a single one of them. One could use chromic gut, but the knot would still be thrown off and the gut would cause more tissue reaction than the hair in a place where the quickest possible union with the least disturbance is most desirable. If needed, an extra suture is added on the under surface.

Fig. 30 Suture—approximating the mucosa. The needle carrying the anterior suture is again picked up and the mucosa edges are accurately coapted all the way back to the base of the uvula with a light running suture which is cut 1 centimeter beyond the last catch without knotting. The posterior pillars are shown to have been united.

A careful inspection of the suture line for bleeding, and of the position of the packs, completes the operation.

Operation for a partial cleft is done on the same general plan except that where the cleft is very narrow and extends only a little way into the hard palate a special aponeurotic suture is not necessary. One could conveniently close the velar clefts without making the lateral incision, the original Warren operation, by elevating the mucoperiosteum from the cleft with a Brophy elevator but the palate aponeurosis should always be severed from the posterior border of the palate process and packing, inserted through the lateral incisions, is a comforting prophylactic against bleeding. Furthermore if, as far as possible one sticks to a basic plan of operation, he will develop a better personal technique and better team work than if he yields to the temptation of making unnecessary variations.

Fig. 30 Secondary operation 2. A case in which there had been practically no closure of the cleft from previous operations, but a complete loss of the right mucoperiosteal flap and a very much shortened palate. The rough area in front of B indicates the palate process covered only by unmovable scar. The dotted lines indicate a flap to be raised from the cheek to replace the right mucoperiosteal flap. b, The cheek flap has been raised and, on the left side, a dotted line indicates the line of incision for splitting the cleft border and the posterior pillar. c, The cheek flap has been sutured into position to form the right half of the palate anteriorly and the two halves of the velum.



Fig 30 a.

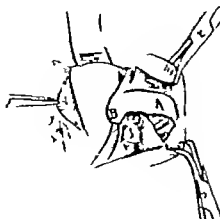


Fig 30 b.



Fig 30 c.



Fig 31 a.

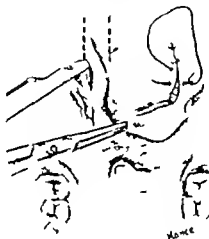


Fig 31 b.



Fig 31 c.

Fig 31. Secondary operation. a Examination showed patient had had a flap turned from the right cheek to fill in the space between first molar and central incisor going back to the base of the first molar on the left side. There is union everywhere with the exception of two places, one to the right anteriorly and one to the left posteriorly. The uvula lies between the molars. Posterior pillars had been brought together for 1 centimeter behind the uvula but the opening between the nasal and oral pharynx is 23 millimeters from before backward and at the posterior pharyngeal wall is the same distance from side to side. He has some action of the pharyngeal muscles.

b Palate was lengthened by freeing the posterior pillars from their attachment to the pharynx almost to the upper pole of the tonsil, then the free border of each pillar was split and the median borders were united (Fig. 31c). This accomplished two things. It released the pillars so that the fauces and velum could be drawn up to the proper level, and it allowed lengthening of the velum until it practically touched the posterior wall of the pharynx (Fig. 31d).

c The palate has been reconstructed so as to extend 3.5 centimeters behind the uvula. There is an opening between the nasopharynx and oral pharynx 0.5 centimeter from



Fig 31 d.



Fig 31 e.

before backward and 1 centimeter from side to side. The speech is good. He still has one opening in the upper fornix mesial of the flap that has been turned in from the cheek, and another small opening lateral of this flap in the anterior part of palate but these seem to cause no inconvenience.



Fig. 32, a



Fig. 32, b



Fig. 32, c



Fig. 32, d



Fig. 33, a

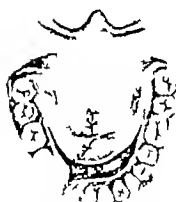


Fig. 33, b



Fig. 34, a

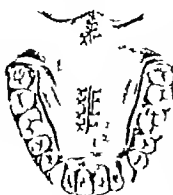


Fig. 34, b

Fig. 32 Secondary operation a, The patient originally had a double cleft of the lip and palate. At operation there were 40 millimeters of a viable flap material, about a 35 millimeter space to fill in and the posterior pillars were free and well developed.

The denuding and relaxing are indicated in Fig. 37.

The second step was similar to that shown in Fig. 31, b and c, but, because we drew too freely on the pharyngeal mucosa, a constriction of the nasopharyngeal opening later developed (see Fig. 32, b). The erysival opening between the nasopharynx and the oral pharynx was enlarged by transverse incision through the oral mucosa at about the level of the upper pole of the tonsils. The mucous mem-



Fig. 33 a.



Fig. 33 b

brane was raised by dissecting it backward for a short distance and at this level cutting through the nasal mucous membrane, thus forming two flaps, one with the base below and one with the base above, the one below being composed of oral, and the one above of nasal mucous membrane. These flaps were curled on themselves and sutured with interrupted chromic catgut so that the entire nasopharyngeal opening was surrounded with mucous membrane. In this way the opening was considerably enlarged (see Fig. 32 c).

d. Final result 7 months following last operation.

Fig. 33 Secondary operation. a. Patient had had von Langenbach operation. Figure 33 a shows horse-shoe incision running around just inside the fringe, from the first molar on the left to almost the second premolar on the right. Dissected flaps back, freshened the edges of the cleft and sutured them together leaving the anterior part of the flaps free (6). (See Fig. 33, b).

Fig. 34 Secondary operation. a. Small defect in central portion of palate is closed by freely undermining through lateral incisions shown and if the defect is anywhere near the posterior border of the hard palate, this must be cut. The borders of the opening are then freshened and sutured as in the first operation. It is seldom necessary to close a bifid uvula, but to save nervousness on the part of the mother it can be closed as shown in this case (Fig. 34, b).

Fig. 35 Secondary operation. a. In palates distorted by previous operation one must adapt the plan to meet conditions. The right half of the uvula was united to the left border of the pillar in this case. The dotted lines indicate the denudation slit placed slightly to the pharyngeal and nasal surface.

b. Shows the suturing of the uvula and pillars, which gave a fairly long velum. The mobilization incisions, as they scar up, will draw the new velum still farther back.

Fig. 36 Closing the double cleft. Considerable difficulty has frequently been encountered in closing the anterior end of a wide open palate cleft. Figure 36—A, B, C, and D illustrate the plan by which we have been able to obviate

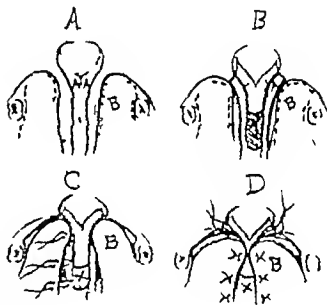


Fig. 36

most of this difficulty. It is usually done as the second step after the lip has been closed. The A flaps are raised from the septum and the sides of the sides of the premaxilla with base above. The B flaps are tongue-shaped with base posterior and contain the major palatine artery. After mobilizing the A flaps, a section is removed from the septum V which permits the premaxilla to move backward in contact with but not in between the maxillae. The cleft was closed by rotating the A flap laterally and superimposing the B flap, raw surface to raw surface, and uniting the 3 mattress sutures. The premaxilla is mobilized, pushed backward, and held there by raising and uniting the mucous membrane across the face of the alveolar cleft. A year or so later the posterior part of the cleft is closed.

the plane of the constricting pharyngeal muscle band.

The basic factor for success or failure and which largely determines operability is the proportion of usable tissue to the width of the

area to be bridged over. At the alveolar border, spare palate tissue is practically nil, so that here it is necessary directly to approximate the bones. This is most easily, safely and accurately accomplished by pressure of

the lip after repair of the lip cleft (4). In the molar region the proportion of available mucoperiosteal flaps increases with the development of the unerupted teeth so that in most instances conditions for closure will be come satisfactory between 1 and 2 years of age (2) (see Fig. 30). In rare instances where the cleft ends anteriorly in a rounded opening bounded by the alveolus and with little or no palate process (see Fig. 16) the operation may have to be postponed for some time and even then some modification of the classic procedure may be necessary.

In older people especially those in whom the soft tissues have been subjected to the pressure of a dental plate which was, heretofore retained by tooth clasps, in palates damaged by previous operation or in extremely wide clefts, the closure can be made possible or more certain by dividing the operation into two steps, first raising and packing under the flaps and in a few days to 2 weeks, after reaction subsides, freshening the borders and suturing (3).

One strong recommendation for the classic Dieffenbach Warren operation is that if done without injuring the major palatine arteries and the flaps should fall to unite at the suture line there will be little visible loss of tissue and the flaps will drop back to a normal position without embarrassment to a properly timed subsequent attempt.

This article is presented not with the idea that we have anything new to offer but perhaps, as a timely review of underlying principles of a usable technique.

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HYDATID DISEASE OF THE BRAIN

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AS in the case of all organs, infestation of the brain with echinococcal disease may be either primary or secondary. In the former the cysts are derived from hexacant embryos which after passage through the liver and lungs have been carried by the carotid arterial stream to the brain. Secondary cysts are metastatic and result from the sowing by the blood stream of scolices derived from a fertile primary simple cyst which has ruptured into the left side of the heart. It is obvious although the fact has not been universally recognized that the pathological and clinical aspects of these two types are very different and until this is appreciated much confusion must occur in their interpretation.

PRIMARY CYSTS

Even in countries like Australia and Argentina where hydatid disease is relatively common primary cerebral hydatid cysts are quite rare. Statistical studies bring out the interesting fact that they are at least seven times as frequently met with in the child as in the adult—the relative figures being 4.9 per cent and 0.7 per cent. This is explained by the fact that infestation with hydatid disease as with other helminthic diseases almost invariably occurs in early life—the period of disregard for cleanliness and personal hygiene and the age of close contact with dogs. Although the greater number (88 per cent) of ingested embryos are held up in the capillary beds of the liver or lung the remainder pass through and are available for distribution to other organs by the blood stream. There seems no doubt that the peripheral distribution of hydatid disease is entirely dependent on the vagaries of the systemic arterial circulation. Owing to the comparatively large size of the carotid vessels in the child a fair proportion of embryos must be carried to the brain where encystment with the formation of a single univesicular cyst usually occurs. As a cyst in this situation grows relatively rapidly because of the soft,

non resistant tissue and the ample blood supply, pressure effects on the brain manifest themselves within a few years so that the child develops signs of intracranial pressure and eventually undergoes an operation or dies, thus adult life is rarely, if ever reached with an intact primary cyst.

As in the case with hydatid disease of practically all organs, the liver as the first filter also often contains a primary cyst of the same age so that the association of hepatic and cerebral cysts is found in approximately 80 per cent of these cases.

Pathology Primary cysts are nearly always single, any case showing multiple cysts should at once be suspected and the possibility of the cysts being secondary considered. They are typically univesicular daughter cyst formation being of extreme rarity and in the few cases in which it has been recorded, has been associated with a history of local trauma to the cranium. The cyst commences its growth in the cerebral substance quietly enlarging until it is big enough to produce pressure effects. Here again the location seems more or less to coincide with the distribution of the blood vessels—the frontal lobe being the most frequent site. As the cyst grows it may impinge on the lateral ventricle on the surface or even erode the skull and rupture in any of these directions may occur, usually with profound anaphylactic symptoms and death. The adventitious capsule laid down by the cerebral tissues is ill defined and at times almost non-existent—a fact well in keeping with the non reactive nature of the glial tissue generally. Adhesions between the meningeal layers may occur as the result of pressure but most of the vague microscopical changes which have been described by some observers as occurring around these cysts seem to have been produced as a result of terminal phenomena.

The nervous tissues are simply pushed aside and even in large cysts it is surprising how little alteration occurs in their structure. The

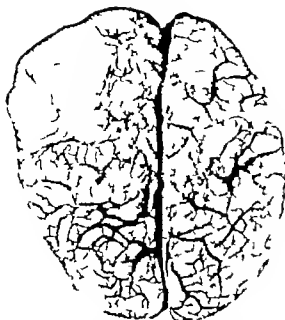


Fig. 1. Unilocular hydatid cyst of occipital lobe of the brain from child aged 12. From the Pathological Museum, University of Sydney.

size to which the cyst can grow and yet be compatible with life is astonishing—cases in children in which more than 20 ounces of fluid were found have been recorded (Fig. 1). This is due to the yielding nature of the skull which prevails during the actively growing period and to the remarkable compensatory powers of brain tissue particularly in young people.

The blood supply of the brain is so ample and the soft nervous tissue so non-resistant that growth is regular and comparatively rapid, while in nearly all cases the cyst is healthy and fertile containing many scolices within their brood capsules. Degeneration, with the production of pultaceous material containing cholesterol and hyaline debris does occur sometimes but no cases of dense fibrosis or calcification have been recorded. Pressure effects may be manifested by distortion or thinning of the skull, either generally or in a localized area, and some remarkable cases have been reported. Pressure on the ventricular system with the production of varying degrees of internal hydrocephalus or ven-

tricular distortion with the production of rapid increase of intracranial pressure is common. Finally localized pressure on certain non-essential areas of the brain may produce—as in the case of other non-infiltrating tumors—typical clinical syndromes.

Clinical aspects. The average age of incidence in the recorded Australian cases is 11 years and this corresponds with statistics from South America. The latency of the disease is remarkable and with the exception of the cystic astrocytomas is greater than that of any other intracranial tumor. As is to be expected, the symptomatology is that of a simple non-infiltrating slowly growing tumor of a cerebral hemisphere and depends on the location of the cyst. General symptoms predominate, and except in a country where hydatid disease is well known the true pathological nature of the lesion usually remains unsuspected. Thinning of the skull which may be reduced to the thinness of paper or even perforated may be detected over the cyst either by palpation or radiography. This contrasts with the hyperostosis of meningeal or osseous neoplasms and is extremely suggestive. Localized tenderness or a cracked pot sound on percussion may also be present.

It follows that the diagnosis in any of these cases will depend on a full neurological examination if necessary the standard ancillary methods of examination which are found so necessary in the localization of many intracranial tumors being used. As in these cases the all important accuracy in localization depends on a very careful analysis of signs and symptoms but it should be possible in the majority of cases. An accurate pathological diagnosis will except in so-called hydatid countries be rarely made.

It would be expected on *a priori* grounds that the Casati intradermal test would be positive in a high percentage of these cases, but in the few recorded cases in which the test has been carried out, the reaction has been negative or equivocal. Further statistics are urgently required to determine the diagnostic value of this test in intracranial hydatid disease. As in the case of simple cysts generally the specific hydatid complement fixation test will be of little, if any value.

The following case history illustrates some of the features mentioned

CASE 1 D P male, aged 13 years, was admitted to the Royal Alexandra Hospital for Children complaining that for the preceding 8 months he had suffered from severe headache which was made worse by exertion or excitement. He had vomited on many occasions, the event having no relationship to the taking of food, but neither the headache nor the vomiting had increased in frequency or intensity. For the 6 months before admission he had noticed that he could not see the blackboard at school plainly but he had never had double vision. Further questioning elicited the fact that he had a tendency to become giddy on stooping and that recently he had had some tingling and numbness in both hands. He had had no serious illness and complained of little except the headache. He had spent all his life on a farm.

Examination revealed a well developed lad—normal for his age in all respects—bright and intelligent in his answers. His head was normal to palpation but measured a little more than normal although there was no suspicion of internal hydrocephalus. There was no tenderness to percussion and no cracked pot sound. Examination of the eye grounds showed equal bilateral papilloedema of approximately a diopters; the visual acuity was somewhat below normal but the fields of vision were normal to both small and large objects. The pupils were equal and reacted to light while there was no nystagmus. Examination of all the cranial nerves was entirely negative while all the peripheral reflexes were equal and active.

Investigation of the appreciation of various sensations in the limbs showed no abnormality.

The gait was not abnormal, nor was there any ataxia or signs of cerebellar involvement.

Radiography revealed a slight increase of convoluted markings, some questionable separation of the coronal sutures but no bony abnormality of any sort. The Casoni intradermal reaction and the hydatid complement fixation test were both negative.

In view of the lack of any local or even lateralizing signs, and because intracranial tumor was suspected, it was decided to perform ventricular estimation. This was carried out under local anaesthesia through two symmetrically placed posterior openings. The right lateral ventricle was struck at a depth of 4.5 centimeters but seemed to be somewhat displaced laterally while the fluid seemed under normal pressure. The left needle struck fluid at a depth of 2 centimeters and this was under a much higher pressure than the right. The asymmetry of the ventricles showed that the lesion was not a centrally placed one and in view of the equivocal findings, the head was rocked from side to side and air allowed to enter in to both needles in turn in order to obtain a ventriculogram. It was at once suggested that the left sided collection might be an hydatid cyst and although no hooklets or scolices were found in the fluid, it had a much higher content of sodium chloride

than that of the normal ventricle—an important diagnostic point.

The subsequent series of radiographs (Figs. 2 and 3) showed a spherical cyst about 4 inches in diameter deeply placed in the left occipital lobe, obliterating the posterior horn of the left lateral ventricle, but not communicating with it. The posterior horn of the right side was somewhat displaced to the right. Across the cyst cavity were several trabeculae which gave the impression of multiloculation.

This appearance was so suggestive that, taken into account with the extreme latency of the lesion, the age of the patient, and the rarity of other cystic tumors in this region it led to the tentative diagnosis of hydatid cyst, and operation was advised.

This was carried out, under local anaesthesia, through a posteriorly placed osteoplastic flap based on the left temporal muscle. When the dura was opened the brain bulged a little and the cyst was tapped, a little brownish fluid being obtained. After due precautions as to soiling of the field, the cortex was excised with the Bovie knife to a depth of 3 centimeters and the air bubble in the top of the cyst opened into without any difficulty. In view of the close contact with the ventricle no formalin was used as a sterilising medium. The fluid was sucked out and the collapsed laminated membrane which had produced the peculiar trabeculation on the radiogram was easily coaxed out in its entirety still containing some fluid. The cavity was then sucked completely dry and the thin ependymal wall of the lateral ventricle with its characteristic pulsation was seen lying bare on the medial wall. Using plenty of Ringer's solution and 'Intene' pledgets the toilet of the cavity was completed, and a little alcohol on cotton wool was used to swab the bottom of the cavity which, after further flushing and drying, was filled with Ringer's solution. The degree of collapse of the hemisphere after evacuation of the cyst was remarkable. The dura and scalp wound were sutured in the ordinary way without any drainage. The patient was returned to the ward in excellent condition, was propped up after a few hours, and made an uneventful recovery. Examination of the fluid and the cyst revealed very few scolices, but a few hooklets so that it is probable that the risk of contamination of the area with hydatid elements was negligible.

The cyst which was well over 10 centimeters in diameter was lying deeply in the occipital region but had produced no interference with the fibers of the optic radiation as it was too far forward and too cranial. Neither had it produced any motor or sensory phenomena owing to its posterior position, and it is certain that had it not been for the performance of bilateral ventricular puncture, which permitted air entry, localization would have been impossible. The laminated membrane of the cyst was only separated from the



Fig. 2 Case . Ventriculogram showing hydatid cyst containing air and some distortion and displacement of ventricular system. Antero posterior view.

lateral ventricle by the thin ependymal lining of the latter so that the patient was in imminent danger of an intraventricular rupture, an event which is almost certainly fatal. It is, indeed, rather remarkable that the exploratory puncture did not, as it does occasionally, in cases of pulmonary cysts, precipitate rupture owing to the sudden liberation of support from the ventricular wall.

The following is an example of hydatid of the cerebellum. This is the rarest location for primary hydatid disease—only two undoubted cases having been previously recorded, both in South America, by Pflaumer and Chiappori. Morquio has recorded a hydatid cyst of the cerebellopontine angle. For this case history, I am indebted to Dr. E. Britten Jones of Adelaide, South Australia.

CASE 3. M. H., a boy aged 3 years 9 months, who had lived all his life on a farm in the country, was admitted to the Adelaide Hospital giving a history of 3 weeks' intermittent vomiting. These attacks came on once or twice a week and were associated with listlessness and drowsiness—between the attacks he was bright and active. The parents had



Fig. 3 Case . Ventriculogram. Lateral view.

never noticed any unsteadiness of gait, nor was there any history of falling.

On examination the patient looked ill, lay curled up on his right side with his head retracted, and periodically he uttered a peculiar cat-like cry. His temperature was normal and his pulse rate varied from 80 to 100 beats per minute showing sinus arrhythmia. There was a paralysis of the right external rectus muscle. The superficial abdominal and cremasteric reflexes were equal and active—the deep reflexes showed no abnormality. Double Kernig's sign was present. A radiogram showed no local thinning of the skull and was regarded as completely negative. He was thought to be suffering from basal meningitis and died suddenly 2 days after admission, following lumbar puncture.

Autopsy revealed a small hydatid cyst about 1.5 centimeters in diameter in the right lobe of the liver and the left lateral lobe of the cerebellum was occupied by a subcortical cyst approximately 3.5 centimeters in diameter which had produced internal hydrocephalus and a definite pressure cone. The latter cyst was univentricular, thin-walled, contained scolices, and had extended to the arachnoid which was so thin over it that at autopsy the cyst fell away. There is no doubt that the hepatic and cerebellar cysts were both primary and both of the same age—the difference in size being due to the more rapid growth in the vascular and non-resistant tissue of the cerebellum. The meningeal phenomena are of interest and are perhaps due to actual stretching and irritation of the arachnoid over it. I have noticed similar phenomena in a rapidly growing neoplasm which had extended into the cerebellar meninges.

The following case, for the record of which I am indebted to Mr. W. A. Hailes, F.R.C.S.

of Melbourne is a good example of what is probably—in the absence of the certainty of complete autopsy—a primary cerebral hydatid cyst in the adult

CASE 3 M.R., a female aged 44 years was admitted to the Melbourne Hospital with a history of severe frontal headache of 6 months duration. The headaches which were at first paroxysmal became progressively worse and more persistent, particularly during the 3 months previous to admission. For the last 2 months her memory had begun to fail, while her responses to questions became uncertain and she exhibited a certain degree of aphasia at times. Three weeks before admission her mother noticed that her speech was slurred, her writing began to deteriorate while a progressive weakness in the right arm and leg developed, so that she could neither feed herself nor walk without assistance.

There was no vomiting and no gross interference with vision although she thought that the latter was not so good as formerly. Neither was there any history of hallucinations of smell or sight.

On examination there were found no signs of disease in the thoracic or abdominal regions. The head showed no abnormality—on inspection or palpation. There was no ocular palsy but there was a right sided facial paralysis of the upper motor neurone type. The hearing appeared to be hyperacute, and there was some difficulty in swallowing although the palate moved normally on both sides. The optic discs showed venous congestion and a doubtful degree of papilloedema. Owing to lack of co-operation and concentration it was found impossible to determine the fields of vision.

The superficial abdominal reflexes were present on both sides but the left was much more active than the right. All the deep reflexes of the right side were much more active than those of the left, but there was no clonus and plantar stimulation gave a flexor response on both sides. There were no signs suggestive of cerebellar involvement. The cerebrospinal fluid was under excessive pressure but was clear and there was nothing abnormal detected therein.

The diagnosis of tumor of the left cerebral cortex involving the lower part of the motor cortex was made and operation advised.

Operation was carried out—an osteoplastic flap being raised on the left side. This revealed in the left temporal region a subcortical swelling which was discovered to be a simple hydatid cyst about 3 inches in diameter. This was removed intact and the wound closed without drainage.

Convalescence was uneventful and 3 weeks after operation the patient reported that the headaches had gone completely while the facial palsy and speech difficulty were clearing up.

Four days after operation a Cassini interdermal test was carried out, the response being a small wheal with a large area of erythema but with no delayed reaction. It would probably have been recorded as an equivocal reaction had not the history been known



Fig. 4. Case 1. Patient 8 months after operation. Hair clipped to show scar.

This case is of interest in that it is probably a primary cyst of the brain in an adult—a rare condition although two other probable cases have been recorded in Australia, while a number of isolated cases have been reported in other countries. The percentage of primary hydatid cysts of the brain in the adult is from 0.5 per cent to 0.7 per cent—a low figure because of the rarity of infestation in the adult and because the embryo has to make its way through the capillary beds of the liver and lung, after which only a small percentage can enter the carotid arteries, owing to the manner in which they arise from the relatively much larger aorta.

Although I have not sufficient statistics for accurate deductions, it is suggested that the left carotid would receive a larger percentage and so cysts of this class should be more frequent in the left cerebral hemisphere. It is probable that in this case infestation with the parasite occurred relatively recently, certainly not more than—judging from the size of the cyst—5 or 6 years previously not a very common occurrence in adults who are not nearly so susceptible to helminthic infestation as children. It is also—arguing by analogy with other cases of extrahepatic cysts—probable that this patient has a somewhat smaller hydatid cyst in the liver, which is at present undetectable but which may manifest itself in later life. Certainly she should be kept under observation for a prolonged period and any symptoms referable to the hepatic area viewed with the greatest suspicion.



Fig. 4. Hydatid cyst of the left lateral lobe of the cerebellum from a child aged 3. By courtesy of Dr. F. Bruten-Jones. The cyst which has fallen out of its cavity has been injected with gelatine hence its dark color.

Treatment of primary cysts. These cysts, like all non-infiltrating intracranial tumors cause death by gradually increasing pressure effects so that surgical interference is the only treatment. Provided localization is accurate, and with modern methods this should always be the case the operative procedure is relatively simple. It should follow the methods laid down so ably by Cushing and his school of neurosurgery, and the operative mortality should be extremely low. It entails the turning down under local anesthesia of a suitably placed osteoplastic flap, the tapping, sterilization and evacuation of the cyst and its laminated membrane followed by closure without drainage. Just as in the case of other univesicular fertile cysts the real risk is infection of the area of operation by scolices. These may, under favorable conditions, form new cysts, and lead after a few years to local recurrence in the form of a multivesicular cyst. This has been recorded on several occasions and must be carefully guarded against. If the cyst is comparatively superficial and if there is no evidence of its actual contact with the walls of the lateral ventricle—partial evacuation through a needle and the injection of 5 to

10 cubic centimeters of commercial formalin which is allowed to act for 2 or 3 minutes, is the procedure to be adopted. This effectively sterilizes all the scolices in a cyst up to at least 12 centimeters in diameter which is probably as large as they are met with in this situation and precludes the danger of sowing fertile scolices in the area of operation. Of course careful packing off with wet pledgets of lintene or similar material is also advisable as an additional safeguard. If the cyst as in the case recorded above has actually bared the thin ventricular wall a protoplasmic fixative like formalin may be inadvisable but every effort should be made by means of suction etc. to clear out all the hydatid elements and then to sterilize the greater part of the cavity with pledgets moistened with Zenker's fluid. With care and a due appreciation of the danger of sowing scolices the risk should thereby be reduced to a minimum.

If the cyst lies deeply it will be necessary to incise the cortical tissue through a silent area usually with the electric knife. In order that the cavity may be easily found, complete evacuation before incision is inadvisable and when the cyst is opened the pump must be ready for full action. The crumpled, brittle, laminated membrane must be removed intact by careful coaxing through this incision after which the above mentioned toilet is carried out. After this is complete the cavity should be filled with a properly buffered Ringer's solution and the wound closed without drainage. After treatment resembles that after removal of any cerebral tumor and should be completely uneventful.

In a previous work on the subject of hydatid disease in 1928 I judging from the reported cases emphasized the gloomy prognosis of these cases, partly because then the mortality in all cerebral operations in children was unduly high and partly because of the frequency of recurrence, owing to contamination of the wound with scolices. Thanks to the work of neurosurgeons, particularly in America who have standardized the surgical attack on intracranial tumors with a resultant remarkable fall in mortality and to the recognition by all observers of hydatid disease of the risk of the spread of scolices in the opera-

tion field, it would seem that nowadays prognosis should be excellent and this, I am sure will be reflected in results in the future

SECONDARY CYSTS

Secondary cysts are invariably metastatic, being derived from scolices brought to the brain by the blood stream. We are almost entirely indebted to D  v   of Rouen for his original experimental work which first placed the pathology of metastatic hydatid disease on a correct basis.

They are always secondary to intracardiac rupture of a primary hydatid cyst of the left side of the heart and are the counterpart of metastatic pulmonary cysts secondary to rupture into the right cardiac chambers.

Following rupture of a primary cyst into one of the left cardiac chambers the scolices and brood capsules are carried into the aorta and owing to the comparatively large lumen of these arteries from 60 to 70 per cent of them make their way via the carotid arteries to the brain—the remainder being distributed to more distant organs. It follows therefore that in these cases the brain cysts are usually multiple—sometimes very numerous although the average number is four—are of approximately the same size are distributed bilaterally and indiscriminately throughout the cerebral or cerebellar substance, and are nearly always associated with cysts of a similar nature and stage of development in organs such as the spleen or kidney.

The fate of the original primary cardiac cyst varies, it may be completely evacuated, undergo fibrosis and obliteration but more often after closure of the rent some residual scolices or brood capsules give rise to reactive daughter cyst formation inside the original cavity so that by the time the metastatic cysts are of an appreciable size a matter of a year or two the original single cardiac cyst is represented by one containing numerous daughter cysts (Fig. 6).

Many such cases have been recorded in the literature but in most of them owing to incomplete observations at autopsy, or to non-recognition of the correct pathological story, their true significance has been missed and the real connection between the cardiac and

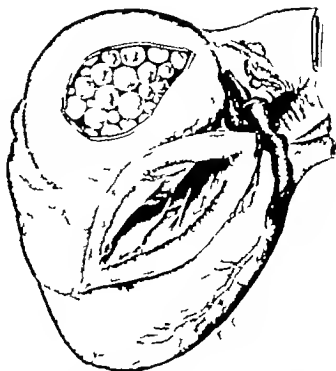


Fig. 6 Multivesicular primary cyst of the cardiac muscle from a patient aged 24. Associated with multiple metastatic cerebral cysts which caused death. From the Pathological Museum, University of Sydney.

the cerebral cysts has not been appreciated. It follows that the discovery at autopsy of multiple cerebral hydatid cysts should always lead to a close examination of the heart for the primary cyst, which will be found either in involution or containing daughter cysts. Conversely a cardiac cyst with daughter cysts should lead to a brain examination.

Clinical aspects. Owing to the fact that the original cardiac cyst must have grown to a size large enough to lead to rupture and to the necessity for a certain time—1 to 5 years—to elapse to allow the cerebral cyst to grow to a size large enough to produce symptoms, this type is rare in children. The youngest patient of which I have any record is a case recorded by Verco and Poulton, a boy aged 14. The average age in an Australian series of 7 cases was 22 years. Practically all cases of hydatid disease of the brain in adults are of this type and so offer a remarkable contrast to the disease in this site in children.

The clinical picture may be divided into three phases and if an accurate chronological story is obtainable these should always be recognizable.



Fig. 7. Case 3. Multiple metastatic hydatid cysts, secondary to a cardiac hydatid. These cysts were all of the same size, that of a pigeon egg and were all simple univesicular cysts. The liver also contained a small cyst of about the same size in the upper part of the right lobe. The lungs were clear but a small hydatid, inches in diameter containing numerous small daughter cysts was found in the wall of the left entrance of the heart. This was in all respects similar to that shown in Figure 6.

1. The initial intracardiac rupture of the simple univesicular primary cyst is usually associated with sudden collapse, urgent dyspnoea, cardiovascular disturbances or varying symptoms of an anaphylactic nature. This is due to the sudden introduction into the blood stream of a sensitized patient of the specific antigen and although in rare cases death may be produced, in the case of a small cyst it is conceivable that little effect would be noticeable. In few if any of the recorded cases has this point been emphasized mainly because it was not searched for but often probably because it had been forgotten by the patient. Careful investigation would no doubt reveal some illness which would suggest an anaphylactic attack. The patient recovers completely and rapidly on examination appears normal then passes into the second phase.

2. A phase of latency extending over a period of 1 to 5 years during which the meta-

static cysts grow while the original cardiac cyst undergoes obliteration by fibrosis or reactive daughter cyst formation.

3. A phase of development of increased intracranial pressure from the growth of the secondary cysts. Owing to the fact that these cysts are multiple and distributed in a widespread fashion it follows that the cerebral signs and symptoms may be protean rather like that due to metastatic neoplastic disease so that accurate localization may be difficult or impossible. As the skull of adults is dense and resistant bony changes are not common—indeed there is nothing in these cases to distinguish them from any other causes of increased intracranial pressure.

Death in this type is brought about, either from the results of increased intracranial pressure, the intensity and rapidity of development of which is dependent on the number of metastatic cysts present, or follows a second intracardiac rupture of the now multivesicular primary cyst. The latter event produces severe anaphylactic shock and owing to the comparatively large size of the daughter cysts, a rapidly fatal hydatid embolism of the main cerebral arteries. The following is a typical history of secondary cerebral echinococci.

CASE 4. K. B. female, aged 18 years, admitted to hospital with signs of increased intracranial tension.

About a year before admission the patient had had an attack of what was, because of the occurrence of vertigo, etc., thought to be "ptomaine poisoning." Some hours after a meal of asveloys she became very ill with vomiting, cobc-like abdominal pains, and collapse. She remained in a more or less unconscious condition for a days. When she recovered consciousness she felt well but could not walk in comfort for some days because of painful contractions in the muscles of her legs. After a few weeks she was apparently normal.

History on admission. Three months before admission she had noticed intermittent occipital head ache and interference with visual acuity. Two months later she noticed weakness of the left upper limb and a week later had attacks of vomiting unrelated to the taking of food. During the last few days the headaches had become much worse and more or less continuous and she had developed photophobia. All her other functions appeared normal.

Physical examination. The patient's face was expressionless and she was mentally dull. She showed ptosis of the right eye but no strabismus, no diplopia, and no nystagmus while the pupils reacted to light and accommodation. Examination of the fundi

showed bilateral papilloedema—more marked in the right eye. Her fields of vision were not charted. There was a left sided facial paresis of the supra-nuclear type, but all the other cranial nerves seemed normal. There was a distinct weakness of the left arm—the dynamometer readings being right 30 left 10. The superficial abdominal reflexes were present but were less active on the right side. The knee, ankle, and arm joints were all equal and fairly active. The plantar reflexes were equivocal but were taken as flexor. The gait was tottering with uncertain equilibrium but there was no tendency to fall in any one direction.

The apex beat of the heart was in the fifth space, 3.5 inches from the midline—there was no increase of right cardiac dullness. A midystolic bruit was heard just inside the apex beat and up to the first intercostal space other cardiac sounds were clear. Lungs and other organs appeared to be normal.

Operation. A right sided cerebral exploration was carried out, great increase of intracranial pressure was found, but as no new-growth or cyst was discovered a simple decompression was carried out. After operation a large cerebral hernia developed and the patient died in coma, some 4 weeks later.

Autopsy. Multiple hydatid cysts of the brain were found, four in left frontal region, one in each parietal lobe, and one in left cerebellar hemisphere (Fig. 7).

This case is classical and instructive. There can be little doubt that the attack 12 months previously was due to hydatid anaphylaxis and coincided with the initial intracardiac rupture of the primary cyst and that the diagnosis of ptomaine poisoning was erroneous. The period of a year's latency followed by the development of the signs of increased intracranial tension coincides with the size of the metastatic cysts of the brain and liver and with the reactive daughter cysts in the original cardiac cyst. The protean and rather puzzling nervous manifestations were due to the multiplicity of the cysts and made accurate localization impossible.

In this case—although in retrospect the diagnosis is easy—a correct diagnosis was not made until autopsy. There is little doubt that in these cases owing to the absorption of comparatively large amounts of hydatid antigen the Casoni intradermal test and the hydatid serological reactions should give

almost universally positive findings but until this is carried out as a routine or until we discover the criteria by which we can detect a quiescent cardiac hydatid the antemortem diagnosis of these cases must always remain a matter of chance.

Owing to the multiplicity of the cerebral cysts and to the presence of a cardiac cyst which is in imminent danger of a secondary rupture no treatment is of any value in these cases and operation is contra indicated.

SUMMARY

1. There are two distinct varieties of hydatid of the brain—primary and secondary.
2. Primary cysts occur almost exclusively in young children, are simple and give rise to similar clinical syndromes to any other benign, non-infiltrating tumors and are amenable to surgical operation.
3. Secondary cysts are metastatic, occur almost exclusively in adults or adolescents, are secondary to an intracardiac rupture of a fertile primary cyst into the left side of the heart.
4. They produce protean nervous manifestations owing to their multiplicity and in variably produce fatal results not being amenable to surgery.
5. The diagnosis of either type may be suspected in "hydatid countries" but even there may depend on positive intradermal or serological reactions.

I have to acknowledge with gratitude the courtesy of Drs. Temple Smith and R. B. Wade of Sydney, Dr. Britten Jones of Adelaide, and Mr. W. A. Hailes of Melbourne who have put their records at my disposal and given me access to their cases.

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THE SURGICAL TREATMENT OF EXOPHTHALMIC GOITER LATE END-RESULTS

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ALTHOUGH the basic cause of hyperthyroidism is unknown the most efficient treatment is the operation of subtotal thyroidectomy. By this procedure the surgeon breaks a vicious circle which involves the thyroid gland, other glands of internal secretion and the sympathetic nervous system.

During recent years, many papers on various aspects of exophthalmic goiter have been published, the great majority from American clinics. The outstanding contributions have been the isolation of thyroxin by Kendall and the rationalization of iodine therapy by Plummer. Many of the articles have dealt with such topics as the technique of thyroidectomy, operative mortality, the multiple stage operation, the management of the poor risk and the thyro-cardiac, the basal metabolic rate and the estimation of end-results. These publications, representing the experiences of authorities in the most prominent clinics, have

served to crystallize our present knowledge of the various aspects of the disease.

Since the earlier years of our experience it has been our belief that the enlargement of the thyroid gland is merely an incident in a general disturbance and that the operation of subtotal thyroidectomy is only a makeshift for want of the elimination of the actual cause of the disease. We argued that, if the same factors which initiated the disease remained active after operation, many recurrences would be noted if the patients were observed for a long period. We, therefore, decided to follow every case indefinitely. This paper then constitutes an analysis of 225 cases of exophthalmic goiter treated on the Second Surgical Division of the old New York Hospital which were carefully followed by repeated examinations during the period of years between 1915 and 1932. It must be emphasized that these were all ward patients, and after discharge from the hospital it was usually impossible to eliminate or correct the factors which seemed to be contributory in initiating the disease. This feature is less important in private patients since their lives may be more effectively regulated. Our private cases, which constitute a larger series, were of necessity not included in the follow-up clinic. The results, both immediate and late, were better than those noted in this series of ward cases, but it has not been feasible to reduce these results to figures.

In the series of 225 patients, there were 179 females and 46 males, a ratio of approximately 4 to 1. Between the years 1915 and 1929, 30 males were admitted for treatment. From 1929 to 1932, there were 26 men. These figures suggest that the incidence of exophthalmic goiter in the male was markedly increased following the great stress and strain subsequent to the depression of 1929.

An analysis of the age grouping reveals the interesting fact that the vast majority of patients fall into the third and fourth decades,



Fig. 1. Approximate line of division when posterior part of lobe is left so as to safeguard the parathyroids and recurrent laryngeal nerve. A, Parathyroid; B, thyroid; C, position of trachea; D, esophagus. Recurrent nerve line between thyroid and trachea (magnification $\times 8$). From *Ann. Surg.* 91:6, 1914, 71.

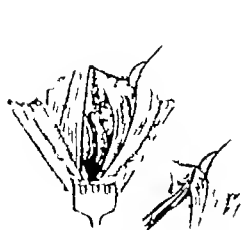


Fig. 2.

Fig. 2. Retraction of sternohyoid and division of sternothyroid.

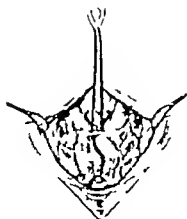


Fig. 3.

Fig. 3. Insertion of special curved clamp between isthmus and trachea. When the clamp is opened the isthmus is separated from the trachea without hemorrhage two

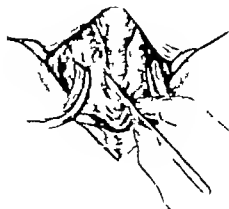


Fig. 4.

special clamps are then placed on the isthmus which is divided between them. From *Surg. Gynec. & Obst.* 1930, 1, 1001.

Fig. 4. Isthmus divided between clamps and dissected from trachea. From *Surg. Gynec. & Obst.* 1930, 1, 1001.

in the period of greatest activity. There were 31 patients in the second decade, 77 in the third, 73 in the fourth, 31 in the fifth, and 13 in the sixth.

The occupations of the patients elicited

some interesting facts. One hundred and two gave their occupations as housewives. Careful questioning indicated in almost every instance either excessive work, financial distress, too many pregnancies or marital difficulties. 77 were listed as factory workers. This group suggests again the possibility of stress and strain as activating factors. The remainder were scattered among the classifications of



Fig. 5. Superior vessels have been divided and lobe freed laterally. Clamps are placed along posterior part of the lobe and lobe removed anterior to them. From *Surg. Gynec. & Obst.* 1930, 1, 1001.



Fig. 6. Resection has been completed leaving a small part of each lateral lobe. From *Surg. Gynec. & Obst.* 1930, 1, 1001.



Fig. 7. Special double tooth thumb forceps approximate skin edges to facilitate application of Michel clips. From *Surg. Gynec. & Obst.* 930, 1, 00

laborers teachers school girls, and stenographers

Many of the patients suggested events in their lives precipitating their illnesses. Thus, 21 indicated that constant worry was a factor 10 had family difficulties in 18 cases there was a sudden death in the family 12 followed severe infectious diseases 8 were precipitated by childbirth and 7 gave maternal worries as a possible cause. In 2 cases the train of events was quite dramatic. Both patients were young women who were badly frightened by a hold up. Within 2 weeks each presented the classical signs of a severely toxic exophthalmic goiter. One of these patients had been seen 3 weeks before in the gynecological clinic and at that time there was no indication of the presence of hyperthyroidism.

The majority of the patients sought treatment within 12 months of the onset of the disease. Thus 79 had symptoms from 3 weeks to 6 months 45 from 6 to 12 months and 28 from 12 to 18 months. There were 31 patients who apparently had the disease for more than 4 years.

A survey of the histories of these patients indicated that the majority presented symptoms usually associated with hyperthyroidism, namely tachycardia, tremor goiter palpitation asthenia nervousness emotional instability dyspnea on exertion excessive sweating and attacks of diarrhea. Approximately 50 per cent showed exophthalmos. Excessive appetite was a common complaint. Menstrual irregularities were frequent. Loss

of weight was common. 11 patients lost from 1 to 10 pounds 51 from 10 to 20 pounds 39 from 20 to 30 pounds and 30 lost more than 30 pounds. Eleven patients stated that there had been no weight loss. The size of the goiter and the degree of toxicity were not commensurate. Many patients with barely recognizable enlargement of the thyroid presented marked toxicity.

The findings on physical examination were fairly constant. Most of the patients presented psychomotor activity mental apprehension tremor sweating muscular weakness enlarged thyroid gland of varying degree, rapid pulse elevated blood pressure skin of fine texture tapering fingers. About 50 per cent presented exophthalmos of varying degrees with the associated confirmatory eye signs. In 108 cases, there was a systolic murmur at the apex. Diastolic murmurs were detected in 8 instances. Ten patients had marked auricular fibrillation. In 88 patients no detectable cardiac abnormality was presented. Cardiac enlargement was noted in 20 cases. Every patient after admission to the hospital, was subjected to electrocardiographic examination. That these abnormal heart findings in most instances, are of but transient significance, is evidenced by the fact that careful follow up studies indicated their eventual disappearance. Six of the 10 patients admitted with auricular fibrillation subsequently regained a normal heart rhythm.

Before the use of iodine (Lugol's solution) in October 1924 the ante-operative preparation of these patients was relatively ineffective and the operative mortality was high. The employment of Lugol's solution in the pre-operative preparation immediately improved the results. The symptoms of exophthalmic goiter as a rule are quickly ameliorated following the administration of Lugol's solution. Elderly patients, however do not respond as quickly as younger ones. Patients who have had iodine before hospitalization are particularly resistant to its pre-operative administration. Some patients were definitely iodine fast. Most of the cases in the latter group were discharged from the hospital to rest for a period of 2 or 3 months without iodine therapy. Upon readmission their

response to Lugol's solution was usually satisfactory. Another group showed marked improvement following the removal of foci of infection as diseased tonsils and carious teeth and subsequently showed a more rapid response to iodine. The usual effect following the administration of Lugol's solution (minims 10 to 15 three times a day) is a marked fall in the basal metabolic rate within eight to ten days, gain in weight, drop in the pulse rate, and general improvement. Some patients need a longer period to exhibit this improvement. Each patient is an individual problem.

The first basal metabolism estimation was done in March 1921. Since then, the test has been in constant use and has proved a most valuable aid in determining the degree of toxicity and the extent of improvement. Within recent years, however, we have relied less upon it as an indication for instituting surgical therapy. Rather are we stressing more the clinical improvement as shown by a drop in pulse rate, general well being of the patient, and particularly, by a definite gain in weight. We feel, in general, that no operative procedure should be attempted in the presence of loss of weight. This must mean that catabolism overbalances anabolism and that thyroid activity is too great to permit of safe surgery. The records indicate that when thyroidectomy was performed during a weight loss severe postoperative reactions or a mortality resulted.

TECHNIQUE OF THYROIDECTOMY

The operation of thyroidectomy is fairly well standardized. There are minor differences in the technique of all surgeons, but they are relatively unimportant. In 1930¹ we reported a method which advised division only of the sternothyroid muscles near their insertion and the division of the isthmus. Division of the isthmus was practiced by us as early as 1915. In most instances splitting of the isthmus is easily done but, occasionally, when it is markedly hypertrophied it is unwise to attempt this method. Although the general details of the technical side are important the thyroid surgeon must evolve for himself an operative procedure which minimizes bleed-

ing, permits of adequate exposure, reduces trauma and can be executed quickly and safely.

Prior to the employment of Lugol's solution, a graded operation consisting of polar ligation followed by unilateral or bilateral lobectomy was commonly employed. We believe that little is accomplished by a polar ligation. Its effect is uncertain. Since 1926 polar ligation has been done in only 2 cases. However it is still occasionally necessary to perform thyroidectomy in two stages, i.e., one lobe and isthmus at the first operation and the second lobe at a later date. The decision as to which patient will need a multiple stage operation comes with experience and cannot be obtained by following any set rules. One is influenced by the intensity of the disease, the course while being prepared for operation, and the reaction on the operating table during the initial procedure.

ANALYSIS OF CASES

Polar ligation. In 17 cases, unilateral or bilateral superior pole ligation was performed and no subsequent surgery was carried out. Five patients died after operation, 4 with symptoms of a thyroid storm and 1 of heart failure. These deaths occurred prior to 1926. Eight of these patients refused to have anything further done. They were followed from 6 months to 4 years. Little change in their conditions was noted. In 1 patient, further surgery was inadvisable because of the development of mental disease requiring state hospital care. One patient, followed for 3 years showed such marked improvement that further surgery was not recommended. Still another was followed for 4 years, at the end of that time she presented none of the signs of hyperthyroidism. One patient died of luetic aortitis 5 years later.

Ligation followed by resection in one or two stages—26 cases. Four died after operation in 2 both prior to 1923. Thyrotoxicosis was responsible for the fatality, 1 developed a wound infection, followed later by hemorrhage. Death occurred on the sixteenth day and autopsy disclosed a large thymus, pericarditis, and pleural effusion. The fourth patient died suddenly 48 hours after operation. Post-

¹ Surg. Gynec. & Obst., 1930, 1, 1001—Fig. 1-7

mortem examination disclosed a hemorrhage into the superior mediastinum.

Careful follow up data are available in the 22 remaining cases. Thirteen patients were followed for from 1 to 10 years, the average period being 7 years. During their entire follow up period these patients remained free from any evidences of recurrent hyperthyroidism and were rated as 100 per cent results. We wish to emphasize that all of the cases reported in this paper were carefully examined following a complete history taking every 4 to 6 months after discharge from the hospital. These personal examinations were supplemented by basal metabolism determinations in many instances. We believe that follow up records based on letters are inaccurate and that a personal approach alone is reliable. We regard this record of our experiences as significant especially from the standpoint of the recurrence rate. Frequently a recurrence was noted before the patient offered any complaints.

The 9 remaining patients developed recurrences that is, enlargement of the thyroid with toxic symptoms. They are herewith summarized.

CASE 1. A small recurrence was noted on the right side after 2 years of good health.

CASE 2. A small recurrence was noted on the left side after 2 years of good health.

CASE 3. After 2 years of excellent health, patient developed a large recurrence following a difficult childbirth. A second resection was done. Two years later she was rated 100 per cent.

CASE 4. After 8 years of freedom from symptoms, this patient was badly frightened in an automobile accident. A few weeks later she exhibited the signs of a mild hyperthyroidism with small nodules in each lobe. After a course of X-ray therapy all symptoms disappeared and the patient has been well for 3 years.

CASE 5. A large recurrence was noted after 1 year. A second resection resulted in an operative mortality.

CASE 6. A recurrence was noted within 6 months. Following the second resection, the patient has remained well 4 years.

CASE 7. This patient remained well for 4 years before she developed a recurrence. A second operation resulted in freedom from symptoms for 2 years. Following a difficult family situation a small recurrence was noted on the right side.

CASE 8. After 2 years of excellent health, a small recurrence developed on the right side. Tonsillectomy and radiotherapy brought relief. This man has been perfectly well for 2 years.

CASE 9. Except for cardiac symptoms due to chronic cardiac valvular disease, this patient was well for 3 years. After severe financial reverses in 1929 a large recurrence was noted. This was again resected in two stages. The patient died suddenly 1 year later of heart failure.

Resection in two stages without previous ligation. There were 3 cases. They are classified as 100 per cent cures after 3, 7, and 9 years respectively. (One patient died after operation of thyrotoxicosis after resection of one lobe, a two stage procedure having been planned.)

Primary resections in one stage. This group constitutes the bulk of the series, 178 cases. There were 7 operative deaths, most of them occurring before 1928. In 5 cases, the cause of death was postoperative thyrotoxicosis. One patient died suddenly of heart failure on the fourth postoperative day. In the seventh case tetany developed and did not respond to treatment. The mortality rate for this group was 3.9 per cent. However the records indicate that most of the deaths occurred in the earlier days of our experience. More recently there has been marked improvement. In the last 107 cases there has been 1 death, or a rate of less than 1 per cent.

Careful follow up data were obtained in the remaining 171 cases. One hundred and fifty followed for from 6 months to 9 years were classified as 100 per cent. In other words, these patients were perfectly well and presented none of the symptoms of hyperthyroidism. Of these 35 were followed 6 months, 41 for 1 year, 37 for 2 years, 18 for 3 years, 4 for 4 years, 9 for 5 years, 4 for 6 years, 3 for 7 years, 1 for 8 years, and 3 for 9 years. Five patients were classified as 90 per cent. Three presented a persistent exophthalmos, and 2 retained their tremor.

In the 16 remaining cases recurrences developed and it is upon these that our interest is centered. They are herewith summarized.

CASE 1. Symptoms returned within 6 months. One year later (1918) a second resection was done. The patient died after operation. This should be classed as a persistent hyperthyroidism because it seemed evident that the resection was insufficient.

CASE 2. A small recurrence was noted after 1 year. The patient was then lost from follow up.

CASE 3 A recurrence was detected after 3 years. A second resection was done. Later a recurrent nodule was felt in the left upper pole. This disappeared after a course of radiotherapy. The patient has remained well for six years.

CASE 4. Recurrence after 1 year. Second resection was then done. Patient has remained perfectly well for 7 years.

CASE 5 This patient a course is quite significant. She remained well for 9 years, when after financial reverses she developed a large recurrence rather suddenly. She refused further surgery.

CASE 6 Two months after operation a large nodule was detected. This should be classed as persistent hyperthyroidism. A second resection was then done. One year later a small recurrence was noted. This responded quickly to X ray. She has been well for 4 years.

CASE 7 Persistent symptoms after 3 months. The resection had not been radical enough. A second resection was done at another hospital. Four years later she returned presenting a large recurrence. She refused further surgery. This patient was constantly combating adverse environmental conditions which could not be corrected.

CASE 8 This patient was classified as 100 per cent for 3 years. Following a harrowing experience in an automobile accident she developed a large recurrence. A second resection was done. She has remained well for 3 years.

CASE 9 After 5 years of excellent health, patient developed a small recurrence with mild symptoms. A change of environment brought quick relief.

CASE 10 Symptoms returned in 6 months, due probably to insufficient resection. Because further surgery was refused, X-ray therapy was instituted. Although benefited she still presents evidences of hyperthyroidism.

Radiotherapy has given us best results with small recurrent nodules. They frequently disappear or are replaced by scar tissue. When the recurrences are large the X ray seems to have little influence.

CASE 11 A recurrence was noted in 6 months. Two years later a second resection was done. The patient has remained well for 2 years.

CASE 12 A small nodule was detected after 6 months. The symptoms were mild. This case was subsequently lost.

CASE 13 A recurrent nodule was detected after 8 months. Basal metabolic rate was 33 per cent. Radiotherapy was instituted. The patient has been well for 2 years.

CASE 14. Within 1 year a large mass was palpable. Judging from the operative description only a partial thyroidectomy was performed. Further follow up data are not available.

CASE 15 This should be classed as a persistent case due to inadequate surgery. Signs of hyperthyroidism returned within 9 months.

CASE 16 This is another case of persistent hyperthyroidism from insufficient surgery. Symptoms returned after 3 months. A second resection was followed by good health which has continued for 1½ years.

There seems little room for doubt that the occasional thyroid surgeon will have a high recurrence rate because of inadequate surgery. Timidity because of fear of injury to the recurrent nerves and the parathyroid bodies and operative indecision because he has not yet developed a standard procedure are probably the reasons for this. At least 7 cases in the above 16 recurrences were operated upon by members of the staff who only occasionally performed thyroidectomies. The occasional goiter surgeon must expect many recurrences. It takes considerable experience to operate efficiently and adequately in this disease. The recurrence rate in this group of 171 primary resections was 9.3 per cent.

POSTOPERATIVE COMPLICATIONS

Not infrequently during the course of a thyroidectomy the anesthetist will inform the surgeon that the pulse rate is rising or that he is not satisfied with the patient's condition and request him to terminate the operation as quickly as possible. Under such circumstances we have made it a practice to leave the wound open, packing it with vaseline gauze or gauze soaked in Dakin's solution. In 2 or 3 days a delayed primary closure may be done safely. The wound was left open sixteen times in this series. Four of these patients died after operation. In 2 cases a mild wound infection resulted. In the entire series there were five wound infections, but none of them was of a serious nature.

Aside from the patients who died there were only 5 instances of severe postoperative reaction. The liberal use of intravenous glucose, morphine, and iodine mainly by vein resulted in recovery. One patient developed a hemiplegia after a cerebral embolus. There was only one instance of recurrent nerve injury. Careful laryngeal examinations were made, as a rule before and after operation. Two patients developed postoperative tetany. One was transient and responded quickly to parathormone and calcium therapy. The

other succumbed mainly because of a thyrotoxicosis

The low incidence of pulmonary complications after thyroidectomy is noteworthy. In this group there were 2 cases of postoperative pneumonia and 2 of massive atelectasis. All 4 patients survived. There was 1 patient who developed pericarditis. This was one of many complications which led to her death.

Three patients developed a wound hemorrhage. In one case it occurred on the sixteenth postoperative day and was one of many complications. The patient died of other causes. In the second case death came suddenly on the second day with few evidences to suggest such a complication. At postmortem it was found that the neck wound was remarkably free of blood but that blood had gravitated into the superior mediastinum. The third patient about 6 hours after operation suddenly developed symptoms to suggest recurrent nerve injury. Laryngeal examination indicated bilateral nerve paralysis. Inspection of the neck showed a marked bulging in the operative area. The wound was opened

widely and the blood clots evacuated. A tracheotomy was then done. This patient recovered quickly and completely regained the function of his vocal cords.

When a wound hemorrhage is suspected and it is severe enough to cause obstructive symptoms, the condition should be treated as an emergency. Wide opening of the wound, evacuation of the blood clots, and the insertion of gauze packing usually suffice.

CONCLUSIONS

1. Enlargement of the thyroid gland is only an incident in the disease of exophthalmic goiter.
2. The operation of subtotal thyroidectomy is but a makeshift for want of the elimination of the actual cause of the disease.
3. If the same factors which initiated the disease remain operative after operation many recurrences will be observed if the patients are followed for a long period.
4. In 194 cases, carefully followed over a period of from 6 months to 20 years, there were 25 recurrences, or a percentage of 7.7.

GASTRIC RESECTION FOR PEPTIC ULCER TECHNIQUE¹

H M RICHTER, M D F A C S, CHICAGO

WIDE resection of the stomach as a routine procedure for simple benign but resistant ulcer of either duodenum or stomach has found a prominent and I believe, a permanent place in the continental European literature of gastric surgery. The American literature reflects a far more conservative attitude yet I believe there is an ever widening circle of accepted indications for more radical procedure. This development has been rather irregular along several lines. The technique has varied and the objective has not always been the same. The purpose of this paper is to present the writer's idea of the objective to be attained in wide resection and to give a short description of the more important steps in the technique.

First it is important to emphasize that neither neutralization nor reduction or elimination of acidity is an objective of resection. These can be attained by simpler means. Neutralization and reduction of acidity are incidentally attained and have the same auxiliary value as when obtained in the simpler operations or by adequate non surgical treatment. The objective of resection is quite different. For all practical clinical purposes peptic ulcer may be said to be almost limited to a very restricted portion of the stomach and duodenum. This is the lesser curvature and distal half or more of the stomach and first portion of the duodenum. This is so true that this may be regarded as a distinct area, the ulcer bearing segment. The objective of gastric resection for a benign ulcer is the removal of this segment. When adequately executed recurrence must be extremely infrequent. Conversely failure with recurrence of ulcer is probably most frequently due to a failure to accomplish a sufficiently wide resection though technical errors such as spur formation badly arranged gastrojejunal anastomosis etc. probably play a part. That we in America have a relatively larger number of failures than is admitted by European surgeons is quite probable for a larger number

of our cases are among the earlier attempts of surgeons not entirely familiar with the technique or the objective sought. What amounts to the removal of the pyloric ring with more or less of the antrum is not to be confused with the operation here described. It is unfortunate that the failures of such limited operations should be included in reports of failures of wide resection. The size of the ulcer its multiplicity the area involved are not to be regarded as factors in determining the extent of the resection. If resection is indicated at all it should be a wide resection.

Few steps in so fully developed an operation as resection of the stomach can be expected to be original. However several operations have been developed differing quite radically from each other in principle and the various steps of these operations have varied in the hands of different surgeons. It is the writer's purpose to describe in detail the more important steps of the operation which he prefers. This is a wide resection of the stomach including especially the lesser curvature, the *magenstrasse* with the end to-side gastrojejunal anastomosis which had its origin in the second operation of Billroth and has been so widely modified. The end to-side operation of gastroduodenostomy more recently developed by Haberer is technically simpler and physiologically logical but is objectionable in that it necessitates very conservative resection of the stomach. The illustrations in Haberer's original paper show an antrectomy which I believe is not satisfactory. It may be considered a satisfactory substitute for the various ulcer excisions and pyloroplasties but not for resection.

PREPARATION OF THE PATIENT

Partial gastric resection is rarely an emergency operation. There is usually adequate time to get the patient in the best possible condition to withstand a major operation. A few conditions may militate against delay for preparation.

Severe hemorrhage can usually be controlled by various means including first and foremost adequate blood transfusions. Occasionally hemorrhage persists and surgical interference is indicated. In such a case a final transfusion just before operation may be of the greatest value. Operation during profound hemorrhage without such a supporting transfusion seems to me to be inexcusable.

Severe starvation and particularly dehydration from high grade pyloric stenosis offers a serious problem. Water salt and glucose intravenously subcutaneously and rectally, and blood transfusions offer ample means of improving the patient's condition sufficiently to operate in most cases. Rarely a jejunostomy may be indicated after the water balance has been adjusted. The jejunostomy should be low enough to permit the required operative maneuvers later. It serves a useful purpose in permitting operation to be deferred until the patient's condition is entirely satisfactory. It should be utilized after the resection until normal feedings can be instituted.

Acute perforation of an ulcer constitutes an urgent indication for operation. Most surgeons prefer some simple method of repair of the perforation to more radical measures. However many patients remain in excellent physical condition for some hours after perforation occurs. As was pointed out years ago by Moynihan these patients are not in shock. The agonizing pain is disabling but the blood pressure remains normal or may rise. The peritonitis is not at first an infective process, but a reaction to a chemical irritant. Under these circumstances resection can usually be performed quite as safely as under more usual conditions. An excessive inflammatory edema about the pylorus and duodenum may make the freeing of these parts more difficult, and constitute the only objection to proceeding with the resection. The peritoneal exudate is not a disturbing factor. It should be removed with an aspirator. After some hours, the inflammatory process becomes an infective affair and the patient's condition becomes poorer. Resection is then contra-indicated.

In the absence of such complications as these, many patients can be operated upon after such usual pre-operative measures as

apply to most major cases. By means of proper dietary measures the use of the nasal or stomach tube to insure emptying of the stomach at night etc., the internist can substantially reduce the size of a dilated stomach and make easier the surgeon's work. Duodenal feeding may greatly reduce the inflammatory swelling about a lesser curvature or duodenal ulcer. Much can be done toward improving the general condition of a patient weakened by greatly reduced food intake or prolonged or repeated minor hemorrhages.

Finally in common with all major operative cases the patient's blood grouping should be determined and there should be on call proper donors to be used should the need arise.

The Levine nasal tube has proved to be of great value. It is passed the evening before operation in cases of retention and allowed to remain or just before operation where no retention exists. Siphonage with or without suction keeps the stomach empty. Toward the completion of the operation, as will be stated later it is pushed down into the jejunum to facilitate early postoperative administration of liquids.

TECHNIQUE

The choice of incision whether median or right or left paramedian must ultimately be a personal one since each has its advantages and some disadvantages. Adequate access is essential. Exploration and operative manipulation should be unhampered. The study includes the condition of the lesser and the extent of its inflammatory fixation to pancreas liver or other adjacent organ. A small duodenal ulcer may be overlooked in the presence of a large deforming ulcer on the lesser curvature. An old gastro-enterostomy usually adds considerable technical difficulties. A pathological gall bladder or appendix must not be overlooked. The appendix is removed routinely at the end of the operation if the condition of the patient permits a pathological gall bladder can usually be removed but its removal may be deferred if it seems best.

After the routine exploration is completed the anterior surface of the stomach is grasped with two heavy forceps to be used as handles (Fig 1). The stomach is drawn down and a finger or two of the left hand is pushed through

the almost bloodless gastrobepatic omentum to admit air to the lesser peritoneal cavity. This maneuver allows the colon to fall away from the stomach and the transverse mesocolon from the gastrocolic omentum. This effect is increased by pushing the fingers of the left hand well into the lesser cavity, raising the stomach and pushing the colon away. There is however a variable extent of fusion between the mesocolon and the gastrocolic omentum. Toward the left the two structures are quite free and fall apart quite readily. Toward the right they are usually extensively fused, though separable to some extent, an item of great importance in the technique of resection.

The stomach is now raised by the "handles" so as to present the gastrocolic omentum as a diaphanous drape showing the vascular arch formed by the coalescence of the right and left gastro-epiploic vessels and their epiploic branches. Toward the left large transparent bloodless areas are seen, one of which is punctured with forceps or fingers (Fig. 2) and with fingers behind them the epiploic vessels are gathered or "bunched," grasped in groups and divided between forceps (Fig. 3). In this way the greater part of the gastrocolic omentum is divided, there being no need for meticulous care to divide individual vessels. The left gastro-epiploic vessels are divided well over toward the left side, marking the site of the intended transection of the stomach on the greater curvature (Fig. 4).

The division of the gastrocolic omentum is now carried toward the right, but here the fusion of mesocolon and gastrocolic omentum endangers the middle colic artery. Two fingers are passed behind the gastrocolic omentum (Fig. 5) and separated, and the mesocolon is thus wiped from the omentum, permitting the latter to be divided well up to the pylorus where the right gastro-epiploic vessels are encountered and divided.

Some question has been raised as to the safety of dividing the gastrocolic omentum below the arch formed by the gastro-epiploic vessels and sacrificing the latter, since they are the main source of blood supply to the omentum. I have carried out this maneuver in a sufficiently large number of cases without

incident to feel safe in advocating it. There is a remarkably extensive network of vessels, large and small, in the omentum which makes for safety. If any doubt is felt, in extremely fat omenta, for example, the division should be made between the arch and the stomach.

The stomach, pylorus and duodenum are now rolled progressively upward and to the right, and the pancreas separated from them by the varied maneuvers of gauze wiping and blunt and sharp dissection. The inflammatory thickening and adhesion of the base of an ulcer on the posterior wall of the duodenum to the pancreas may obliterate the plane of cleavage and make difficult the dissection. Actual penetration of the ulcer into the pancreas may necessitate opening into the ulcer in the process of separation. The previous use of the Levine tube and the proper placing of gauze swabs will prevent undue soiling. A considerable cavity may have been excavated in the head of the pancreas by such an ulcer. Its toilet consists in swabbing with iodine or any other satisfactory disinfectant, and tucking a tag of omentum into it, retaining the latter with a few sutures. Such an excavation however must add an element of danger of infection and drainage may be justified.

For such penetrating ulcers, the technical difficulties and added danger of infection may justify division of the stomach proximal to the pylorus, inverting the stump and leaving the ulcer behind, the ensuing steps of the gastric resection remaining the same. This procedure was advocated by Finsterer. If possible the mucosa of the remaining segment and especially the pyloric ring itself should be removed. Because of its funnel shape it will be found difficult to invert the stump without removal of the mucosa unless a considerable segment is left behind, which is objectionable. I have carried out this procedure in a small number of cases, with no failure to date, but would do so only where complete resection is impracticable.

Mobilization of the first portion of the duodenum having been continued to the extent of separating its lower border from the pancreas, a Kocher dissector or curved forceps used as a dissector, is insinuated between it and the pancreas at a point beyond the ulcer,

raising it from its bed. It is grasped with two forceps between which it is divided (Fig. 6).

The duodenal stump is inverted by a Parker Kerr suture (Fig. 6) fine catgut reinforced with a few fine silk sutures being used. For further insurance omentum may be tacked to it or it may be sutured to the pancreas.

The pyloric stump is still held by a reflection of the peritoneum from its upper border the right gastric artery and the remains of the gastrohepatic omentum previously punctured with the fingers. These are progressively divided the right gastric vessels being the only structures of importance. It is necessary however to hug the duodenum and pylorus closely. The stomach may now be drawn well to the left thus exposing to more ready access the left gastric artery as it extends from behind in a fold of peritoneum toward the lesser curvature of the stomach.

The left gastric artery approaches the lesser curvature of the stomach from behind reaching the border at a variable distance from the cardia. The higher it is divided the better it permits mobilization of the stomach. It is hardly necessary however to divide it before it reaches the lesser curvature except for an unusually high lying ulcer. For all practical purposes, high division on the lesser curvature (Fig. 7) and division of the stomach at this site suffices to remove practically all of the lesser curvature which is the object to be attained.

The choice of the site of division of the stomach has varied with different surgeons. Some leave a large part of the lesser curvature the resection really amounting to an antrectomy. Finsterer divides it in a line parallel with the long axis of the body just to the right of the cardia, thus removing almost the entire lesser curvature. It has been suggested that after dividing the stomach the lower end of the remaining segment be cut off obliquely or even transversely apparently with the purpose of easing the spilling of the stomach contents into the jejunum as if it were a functionless bag. Reichel and later Polya, sutured the entire end of the stomach into the side of the jejunum. Hofmeister, Wilms, and later Finsterer partly closed the end of the stomach at the lesser curvature border. I be-

lieve that Finsterer's combination of subtotal removal of the lesser curvature spur formation by partial closure of the end of the stomach, and vertical position of the stoma in the standing position of the patient, is correct and should form the technical basis of all gastric resections for ulcer. While the division of the stomach as here described is carried downward and to the left for the purpose of removing more of the greater curvature than Finsterer the vertical position of the stoma is maintained by suturing the opening in the mesocolon to the stomach above the anastomosis in the usual manner. The sacrifice of more of the greater curvature is intended solely for the purpose of making it technically easier to unite greater curvature to jejunum without spur formation.

The stomach is now raised vertically and a strong straight clamp applied to it just distal to the site of ligation of the left gastric and gastro-epiploic vessels. Thus the clamp is placed not parallel with the long axis of the body but obliquely from above downward and to the left. The division is made proximal to and parallel with the clamp as follows with the stomach and clamp turned well over toward the left the posterior wall is exposed (Fig. 8). The incision close to the clamp is carried through peritoneum and muscularis down to the submucosa readily recognized by its numerous vessels. Peritoneum and muscularis are easily pushed back with the scalpel thus exposing an ample width of the submucosa, permitting the larger vessels to be grasped with forceps. This incision is carried from border to border and all necessary forceps applied then the incision is carried through the remaining thickness of the stomach wall between forceps and the clamp previously applied. The aspirator evacuates any remaining excess of liquid in the opened stomach. Additional forceps are applied as needed additional gauze swabs are placed and the stomach is turned to the right, thus exposing its anterior wall, which is treated exactly as was the posterior wall.

It will be noted that the clamp prevents spilling and back bleeding from the segment of stomach removed and insures division in a straight line also that the clamp is placed on

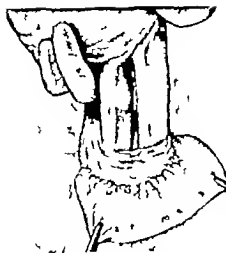


Fig. 1

Fig. 1. With the stomach drawn down the bloodless gastrohepatic omentum is punctured, admitting air to the lesser peritoneal cavity.

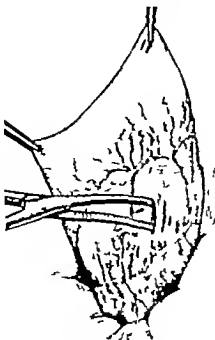

J. B. Taylor

Fig. 2

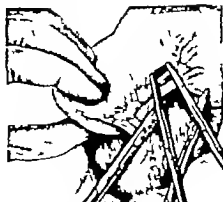


Fig. 4

Fig. 2. With the stomach raised, a bloodless area of the gastrocolic omentum is punctured and enlarged for the admission of the fingers.

Fig. 4. The left gastro-epiploic vessels are divided well over toward the left, marking the site of division of the stomach on the greater curvature.

the part of the stomach that is removed. No clamps are used on the parts remaining.

Fine (No. 00) catgut ligatures are applied. The open end of the stump of the stomach may be reduced substantially in size during this process of ligation of its vessels, particularly by including two or more vessels in each ligature. The open end of the stomach may be sutured directly into the side of the jejunum, as by Reichel, Polya, and others.

I believe that it is preferable partly to close the end at its lesser curvature border. The formation of a spur at this situation serves to prevent the passage of stomach contents in the wrong direction (toward the duodenum). It also permits more accurate determination of the size of the stomach.

The closure is performed as follows: a fine catgut (No. 00) suture is placed at the lesser curvature through the full thickness, tied, and the short end left long enough to be used for traction. The needle is then reinserted from within outward, emerging on either side of the median line about half an inch back of the free cut edge. The edges are now inverted by a continuous through and through suture of the Parker-Kerr type, until the desired size opening is left. Instead of depending upon this single inverting suture, which I have found perfectly satisfactory, an extra hemostatic

suture may be applied in the usual manner. I have used this suture only in the presence of annoying persistent oozing. A third suture, layer to layer, is quite unnecessary.

The end of the stomach is now anastomosed to the side of the jejunum by any preferred method. Of the more important details the following should be noted:

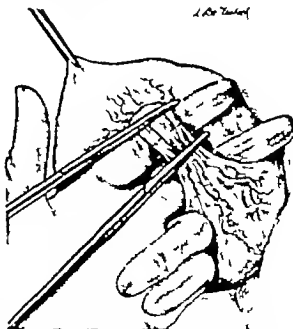


Fig. 3. Epiploic vessels in gastrocolic omentum are "bunched" by fingers passed behind the omentum and divided in groups rather than individually.



Fig. 5 Two fingers passed behind the gastrocolic omentum toward the right push the mesocolon down to protect the mesocolic vessels while dividing the omentum. The right gastro-epiploic artery is ligated as it appears beneath the border of the pyloric area to the right.

The anastomosis is made close to the origin of the jejunum the ligament of Treitz being divided if necessary to prevent angulation. Following Billroth the earlier resections were followed by a long loop antecolic anastomosis between stomach and jejunum to which Braun later added an entero-entero-anastomosis to drain the jejunal loop. I believe the long loop gastrojejunal anastomosis with or



Fig. 6 A curved forceps is introduced beneath the duodenum which is divided between forceps. The Parker-Kerr type of suture which inverts the cut edge.

without the Brann anastomosis adds a substantial danger of gastrojejunal ulcer and should be avoided. The jejunum is carried up a short distance over the sutures originally placed in the partial closing of the cut end of the stomach, reinforcing them. This elevation and angulation of the jejunum also serves an important function in preventing regurgitation.

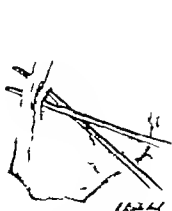


Fig. 7

Fig. 7 The left gastric artery is divided at the level of division of the stomach after the lesser curvature is reached. In very high lying lesser curvature ulcers it is divided before the lesser curvature is reached.

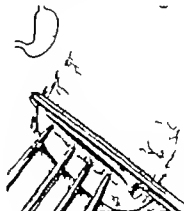


Fig. 8

Fig. 8 With stomach turned sharply to the left, the left gastric and gastro-epiploic vessels ligated, the posterior surface exposed, forceps are applied to the submucosal vessels before division of the full thickness of the stomach wall. The stomach is then opened between forceps and clamp.

tation of stomach contents toward the duodenum (Fig 9)

Special care should be used to avoid making a spur where the greater curvature of the stomach meets the jejunum. A spur is all too easily formed here by unnecessary reinforcing sutures (Fig 9)

If a Levine nasal tube has been introduced it is now fished out of the stomach before the final closure is completed, drawn down 6 to 8 inches and inserted distally into the jejunum. It permits the immediate introduction of liquids if indicated.

SUMMARY

Removal of the ulcer bearing segment of the stomach and duodenum is advocated as a routine procedure in resistant duodenal and gastric ulcers.

Such a resection aims primarily at the subtotal removal of the lesser curvature and the distal half or more of the stomach.

Spur formation at the lesser curvature border of the cut end of the stomach, the attachment of the jejunum so as to reinforce this

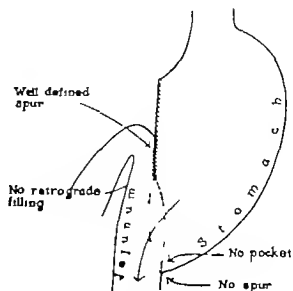


Fig 9

spur, the attachment of the stomach close to the origin of the jejunum, and the avoidance of a spur at the junction of the greater curvature of the stomach with the jejunum, are regarded as necessary features in the technique.

These steps prevent retrograde filling of the duodenum with stomach contents.



Fig. 5 Two fingers passed behind the gastrosplenic omentum toward the right push the mesocolon down to protect the mesocolic caecum while dividing the omentum. The right gastroepiploic artery is ligated as it appears beneath the border of the pyloric area to the right.

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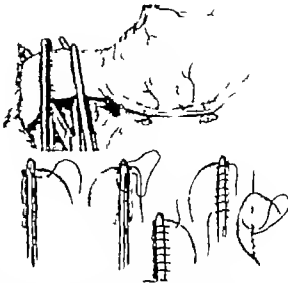


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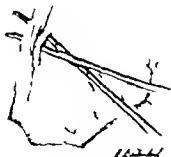


Fig. 7

The left gastric artery is divided at the level of division of the stomach after the lesser curvature is reached. In very high lying lesser curvature ulcers it is divided before the lesser curvature is reached.



Fig. 8

Fig. 8 With stomach turned sharply to the left, the left gastric and gastroepiploic vessels ligated, the posterior surface exposed, forceps are applied to the submucosal caecum before division of the full thickness of the stomach wall. The stomach is then opened between forceps and clamp.

Two chondrosarcomata of the tendons are recorded in the Laboratory (Fig 3) Jones has reported a case of a chondrosarcoma of the quadriceps tendon associated with chondrosarcoma of the knee joint and exostosis Buxton has described a chondrosarcoma which developed on both sides of the tendo achillis in a girl 17 years old This specimen is preserved in the museum of the Royal College of Surgeons. The cartilage was derived apparently from connective tissue and in places had undergone ossification In the benign tumors calcification and ossification appear beneath the capsule of the lobules In the malignant cases cellular precartilaginous connective tissue is found in these areas.

The histogenesis of intracartilaginous ossification observed in long bones is repeated in these tumors—a transition from connective tissue to cartilage and then to bone The tumors of the tendon sheaths develop from undifferentiated precartilaginous foci found within the sheath (Fig 4)

Cartilaginous and osteocartilaginous non-neoplastic lesions are associated usually with osteophytes, developing in chronic arthritis and in cases of huritis These lesions give rise to some pain following repeated and excessive motion Severe symptoms are rare unless trauma or infection occur If such lesions take on rapid growth, a malignant change is suggested and wide excision practiced

Ganglions of tendon sheaths A ganglion is an oval cystic tumor occurring in adults about the wrist or ankle or on the extensor surface of the wrist or dorsum of the foot. Occasionally they are found about the knee joint, and rarely about the hip Baumecker has reported 1 case and cited another about the hip joint Borchardt has reported such a tumor in the tendon of the long head of the triceps some distance from tendon sheath or joint capsule The ganglion contains many dilated spaces surrounded by connective tissue which contain jelly like, translucent material Usually the tumor is attached to the tendon sheath or joint capsule by a fibrous band They do not communicate directly with the joint There has been much discussion as to their nature and etiology since the time of Ellers (1746) At one time they were thought



Fig 1 Myositis ossificans progressiva with ossification of the ligaments and tendons and the spinal muscles The patient was a white male aged 15 who had limitation of motion about the back since earliest childhood Biopsy of the tendons at their insertion into bone showed that the ossification was proceeding via cartilage.

to be herniations of synovial membrane from the joint or tendon sheath Clarke in 1908 regarded these as neoplasms of connective tissue origin This view has been generally accepted They do not have a true endothelial lining They present the same regressive changes that occur during embryonic life in the precartilaginous tissue during the formation of joint cavities and anatomical and adventitious bursae in later life Many of the ganglions found in unusual locations are probably adventitious hursae.

Forty of these small tumors are recorded in the Laboratory and have been studied microscopically All except five related to structures about the wrist. Four were found about the ankle one at the knee One occurred in a

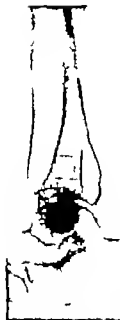


Fig. 2. Osteochondroma in the tendo achillis of a white male aged 21. The patient has remained well without treatment or change in the condition during the past ten years.



Fig. 3. Chondrosarcoma occurring in the tendo achillis in a woman of 5 years. There had been pain and tumor formation for 2 years at this site following an injury. The leg was amputated following a biopsy of the lesion. Chondrosarcoma with many fetal cartilage cells was found invading the tendon upon pathologic examination.

child of 2 another in a child of 11. The remainder occurred in adults.

Giant cell tumor of the tendon sheaths. There is considerable difference of opinion as to the origin and pathology of the very common giant cell tumor of tendon sheaths. Some have called these synoviomata, endothelioma, myxoma, xanthoma, and granulation tissue tumors. Because of the relationship to sesamoid bones and because the tissue from which they develop is related to the skeletal blastema we prefer the term giant cell tumor or xanthomatous giant cell tumor of the tendon sheaths.

In a previous report from the Laboratory (Geschickter and Copeland, 1929) the literature was reviewed and 27 cases were added to the 144 collected by Mason and Woolston making the total 171. Twenty three additional cases have been studied in the Laboratory and 6 other cases have recently appeared in the literature (Bennett, Dudley, Ragins, King, Bellell, and Jebens). In a recent review (King, 1931) the pathological relationship to other neoplasms of the tendon sheaths is discussed.

Thirty two of the 50 cases recorded in the Laboratory were located in the sheaths of the tendons of the finger at the metacarpophalangeal or interphalangeal joints, as a rule on the flexor surface. The remainder with few exceptions were elsewhere on the hand or about the foot and ankle. All the patients except 5 were adults the majority being between the ages of 30 and 40 years. The youngest patient was a boy of 7 years. The tumors ranged in size from that of a pea to that of an adult's fist. The history, as a rule, extended over years. A review of our cases and those in the literature shows a definite relationship between these tumors and that of sesamoids observed in man so carefully described by Pfizner. The evidence that sesamoids embedded in tendons are the point of origin of these tumors, is based upon histological study. In addition to phagocytic giant cells, foam cells and blood pigment these tumors contain fibrocartilage and occasionally bone. Many of the tumors in our series have a stroma of fibrocartilage, 3 contained bone. King also noted a frequent transition to cartilage and occasionally to bone.

Sesamoid bones develop from fibrocartilage and are frequently incompletely ossified.



Fig. 4. Photomicrograph showing the insertion of the normal tendons into bone from an arm of an adult, amputated for tumor of the hand. At the upper margin are shown normal bone spicules. At the lower margin the fibrous substance of the tendon is seen. Between is seen a transition from fibrous tissue to bone via cartilage.

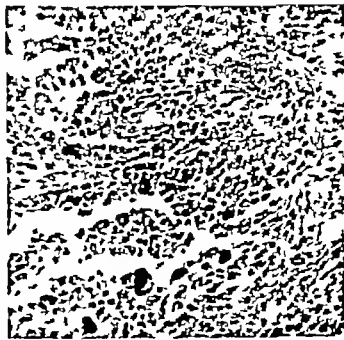


Fig. 5. Photomicrograph of a giant cell tumor of the tendon sheaths.

Following the phase of calcification giant cell proliferation occurs which is closely related to that occurring in the tumors under discussion. Study of the embryology and anatomy of the sesamoid bone supports the view that the majority of giant cell tumors of the tendon sheaths arise from sesamoid bones. Xanthomatous tumors are most apt to involve tendon sheaths, bursa and joints diffusely and are less likely to recur after excision or to invade bone than true giant cell tumors which may also contain cells of the xanthomatous type because of lipid phagocytosis (Fig. 5).

Giant cell tumors of the tendon sheaths are usually small and benign. Two cases in our series recurred after removal, three invaded bone. Bessessen has reported a case on the middle finger of a man aged 27 years which recurred. Ragins found reports of 6 cases in the literature which invaded bone. Simple excision should be practiced.

Giant cell tumors of the patella. The patella is really a sesamoid bone. Giant cell tumors of this bone are much like those just described. Three cases of giant cell tumors of the patella are recorded in the Laboratory. Histologically they are like the giant cell tumor of tendon

sheaths and the same type of tumor occurring in the ends of long bones. Such tumors have been reported by Cole, King and Towne and by Kraft. While giant cell tumors of the patella are not common, chondromata and cysts of this bone have been reported showing that the same pathological changes may occur in the patella as in other sesamoids and tendon sheaths. Neurnbergk has collected 37 tumors of the patella, adding 2 of his own and 6 others which had not been reported.

Lipomata, fibromata and fibrosarcomata of the tendon sheaths. Connective tissue tumors not related to precartilaginous and preosseous tissues are rare in tendons and tendon sheaths. Lipomata are more common in the synovial membrane of joints than in tendon sheaths. Strauss found 18 in the literature which were definitely connected with tendon sheaths. He quotes from Billroth who first mentioned the possibility of these tumors in tendon sheaths. "In synovial folds and villi of the joints as also in the tendon sheaths there may be abnormal fat formation so that the masses of fat seem to be branched like a tree (Mueller)." The majority of the cases are of the arborescent type, some simple lipomata, all are attached to the sheath. The majority of the patients are young adults who had had symptoms from 1 to 19 years. The

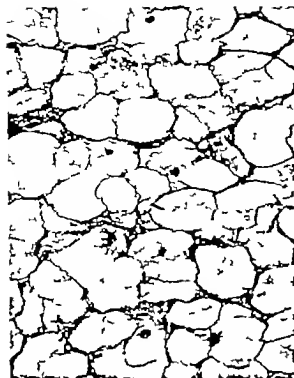


Fig 6 Embryonic lipoma occurring in tendon sheath about the knee joint. Large foam cells transforming into adult fat are shown.

extensor tendons of the hand and feet are most frequently involved. One case in which the extensor tendons of the forearm were involved was bilateral. There is nothing remarkable about the microscopic appearance of these lesions. They are typical lipomata. At operation a soft, fluctuant, lipid growth is found which surrounds the tendon which tunnels the folds of fat. The sheath must be excised with the tumor. Occasionally a smaller lipoma has been reported projecting from the sheath. Recently Straus (F. H.) has reported a lipoma of the hand about the lumbricals on their dorsal side. Valdoni also reported the case of a male aged 19 years with bilateral lipomata affecting the tendons of the hand and feet. Those on the hand recurred after operation. Most of the villous growths of the tumor were attached to tendon sheaths, some were free.

There are only two recorded in the Laboratory. One of these was in front of the patella and not associated with a lipoma of the knee

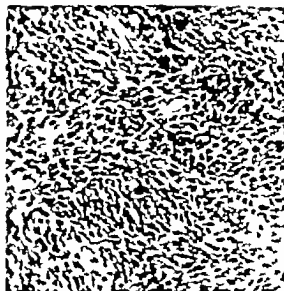


Fig 7 Fibrosarcoma in the quadriceps tendon occurring in a boy of 9 years. There was a recurrence of the tumor following excision.

joint (Fig 6). Another was in front of the elbow joint and surrounded the muscles and their tendons. No typical arborescent lipoma arising from the tendon sheaths of the hand or foot is recorded.

Fibromata of the tendons are as rare as lipomata. Buxton collected 13 fibromata from the literature. Torchiana recently reported a case in a woman aged 30 years who had a tumor in the palm of the hand which recurred after operation. The tumor was histologically a fibroma and involved the tendons of the third, fourth and fifth fingers. Wright Smith has also reported a case of a male patient 21 years of age who had a tumor of the tendon of the ring finger. This was on the flexor tendon, and a history that it followed trauma was given.

Four cases of fibromata are recorded in the Laboratory. One developed above and behind the clavicle in the anterior scalenus muscle. Another developed in a tendon on the dorsum of the hand. The 2 others occurred about the knee joint in the tendons of the semimembranosus and quadriceps. These tumors were definitely encapsulated and easily excised. Histologically they resembled exuberant scar tissue: bundles of collagen and long connective tissue fibers staining heavily with eosin.

being found. The cells were fairly tightly packed together and the collagen made the tumor far more dense in the gross than nerve sheath tumors with which they may be confused.

Fibrosarcomata are probably the rarest of all tumors occurring in tendon sheaths. Many, formerly regarded as sarcomata are now known to be the benign giant cell tumor. King presents a photomicrograph of a malignant spindle or mixed cell sarcoma. He does not give the history of the case. One doubtful case is reported by Krogius which recurred. This tumor occurred in a woman of 21 years of age. It developed in the sheath of the flexor longus hallucis. It recurred and in the recurrence xanthoma cells were found. Recently Cooperman has reported a tumor which developed 2 months after an injury. It became as large as an egg and occurred in a female patient aged 21 in the flexor tendoo of the little toe of the right foot.

Five primary sarcomata of the fascial type involving the tendons and tendon sheath are recorded in the Laboratory. All these were in children or young adults. Two occurred in the quadriceps tendoo and were located laterally or beneath the patella (Fig 7). One was in the tendo achillis, another anterior to the ankle joint, and the fifth above the phalanx. All of these tumors were dense firm and composed of closely packed small spindles. All of these recurred after primary excision. Two of the recent cases were irradiated with out results. The follow up on these patients showed death with metastases in two instances. The other patients could not be traced.

CONCLUSIONS

Among neoplasms of the tendon benign osteochondromata ganglions and giant cell tumor or xanthomata predominate. These tumors show a relationship to precartilaginous tissue. Fibromata and lipomata also may occur. Tumors of the tendon proper and sarcoma are rare. Chondrosarcoma at or near

the insertion of tendon into bone, and fibrosarcoma of the tendon sheath are two rare forms of malignancy found in these structures.

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THE PRESENT STATUS OF THE SURGICAL TREATMENT OF PEPTIC ULCER¹

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IN spite of the fact that the etiology of peptic ulcer is still unsettled we now have several methods of treatment that are satisfactory when properly applied to the condition for which they are appropriate.

It has never been difficult to produce an acute ulcer of the duodenum experimentally but only in comparatively recent times has it been possible to produce a chronic ulcer at will. This has been accomplished by Mann, Dragstedt and others. It has long been realized that the concentration of free acid in the stomach is an important factor in the etiology of the condition but that variations in the concentration of the acid did not explain the whole situation. Recently Matthews and Dragstedt concluded that the chemical action of pepsin hydrochloric acid is the outstanding factor in the production of acute and subsequently chronic peptic ulcer although gastric motility, trauma to the mucosa, and general systemic conditions help to promote the progress of the process. It is also known that some individuals are particularly prone to the development of ulcer and that heredity possibly plays a part. In some instances, infection or toxins may exert considerable influence. Wilkie lays much emphasis on irregular habits of living.

Certainly any logical treatment of this condition whether medical or surgical must be directed toward correction of the recognizable factors in the etiology of the disease. The choice of treatment for duodenal ulcer depends on the duration and severity of the symptoms, the extent and type of the lesion, and the age and temperament of the individual.

Under some circumstances it is permissible to give medical treatment a trial, provided the patient can be kept under close observation, but the measure of success to be derived from this plan depends upon strict attention to detail. Furthermore, there is a particular type of patient who usually obtains more benefit

from this regimen than from any other. He is the nervous, high-strung individual whose history usually discloses that the symptoms are exaggerated by even a slight increase in nervous strain. Experience shows that even though it may be possible to accomplish healing of the ulcer he is prone to have a recurrence of the lesion regardless of the method of treatment. For this reason any operation that may be employed will give unsatisfactory results. The best that we can hope to accomplish for these patients is to keep the symptoms under control a part of the time. It has also been recognized that the results of surgical treatment of peptic ulcer in very young individuals is often not completely satisfactory. There is still another group of patients in which repeated courses of medical treatment will be the most logical plan. They present symptoms that are more or less typical of ulcer yet the laboratory tests fail to confirm the presence of the lesion. If surgical treatment is finally demanded in these cases, it should be confined to the local operation, that is to removal of the cap of the duodenum together with the ulcer and the anterior two-thirds of the pyloric sphincter muscle making closure as a gastroduodenostomy. Gastrojejunostomy is most unsatisfactory in this particular type of case. If there is perforation, obstruction, hemorrhage or a history of progressive recurrent symptoms, in spite of well controlled medical management surgical treatment is indicated.

The first operations were carried out for the relief of obstruction. The Billroth I procedure and gastro-enterostomy were first used in 1881 to overcome obstruction due to malignancy but were soon employed for the treatment of benign lesions. In 1885 the Billroth II operation was introduced. A plastic operation on the pylorus was carried out by Heineke in 1886. Mikulicz, working independently and without knowledge of Heineke's work, devised a similar procedure in 1887. In 1891 Kocher

performed an end to-side gastroduodenostomy following pylorotomy. To Jaboulay is attributed the first suggestion of the possibilities of lateral gastroduodenostomy in 1892. The first clinical application of this was made by Henle, in 1898 and he gave Mikulicz credit for the plan. Finney stated that his gastropyloroduodenostomy, better known as Finney's pyloroplasty, was an outgrowth of that work. Gastrojejunostomy remained the procedure of choice because of the ease of application and the high percentage of satisfactory results that could be obtained. But the incidence of jejunal ulcer later made it apparent that this procedure was not applicable to all cases.

The experience of European surgeons influenced the growing popularity of partial gastric resection for duodenal ulcer. Then followed a great variety of modified Billroth I and Billroth II operations. Von Haberer in 1922 and Finney, in 1924 working independently advocated end to-side gastroduodenostomy following pylorotomy and partial duodenectomy. Others were using the Pólya type of resection of the stomach. Partial gastric resection was advocated and carried out on the theory that it removed the acid bearing and ulcer bearing portions of the stomach. More recent studies show that the acid producing cells are situated in the fundic portion of the stomach which of course nullifies the argument for this radical procedure. And it is also realized that in this country we do not encounter the same type of lesion that the European surgeon has to contend with, the ulcer with an associated extensive gastritis. The lesion that occurs in patients in this country does not justify the adoption of the radical operation employed by the European surgeons. In our experience, there is possibility of recurrence of the lesion even after such resection and the radical operation makes further surgical treatment difficult and hazardous. It is probable that resection of the greater part of the stomach does not afford any better protection against stomal ulcer than the simple gastrojejunostomy.

In an effort to find a procedure that would leave the upper digestive tract in a condition

more in keeping with its normal anatomy and physiology, numerous plastic procedures on the pylorus have been devised. In the first place it seemed reasonable to expect that removal of the lesion itself would give some added advantage in the control of the pathological process, but this alone was not sufficient. Elimination of the action of the pyloric sphincter was recognized as necessary in order to relieve spasm, which causes persistence of symptoms in many of the cases. Removal of the cap of the duodenum with the ulcer and the anterior two-thirds of the ring of the pyloric sphincter not only extirpates the lesion but also eliminates all possibility of spasm due to sphincter action. Closure is then made by gastroduodenostomy which re-establishes the normal continuity of the gastro-intestinal tract. Exposure for this operation is not difficult if it is not attempted in cases in which the ulcer is at some distance from the pylorus or in which the duodenum is too firmly fixed to be readily mobilized. This operation is applicable in at least 50 per cent of all cases of duodenal ulcer.

In the cases in which the duodenum cannot be mobilized without undue risk and in which it is not feasible to do a gastrojejunostomy, it has been found that a satisfactory lateral anastomosis can be made between the first portion of the stomach and the first portion of the duodenum, the pyloric muscle being left undisturbed. Wilkie has used a somewhat similar gastroduodenostomy except that the second portion of the duodenum is employed in making the anastomosis, thus leaving the first portion of the duodenum looped above the anastomosis. The procedure has been criticized because it permits retrograde flow of the gastric and duodenal contents into the ulcer. By making the anastomosis in the first portion of the duodenum just below the ulcer this situation is obviated. It is true that if the ulcer has not been removed, but under conditions that are imposed by the lesion heals quite readily, satisfactory results from lateral gastroduodenostomy in 89 per cent of cases observed from 1 to 12 years. The procedure occurred in only 2 cases, in which it had apparently had no effect.

upon the symptoms produced by it, although the gastric acidity had been lowered.

In a review of our cases in which lateral gastroduodenostomy was performed 1 to 10 years ago in only 1 case was an unsatisfactory result reported. This patient found that he had to adhere to a modified ulcer regimen with the occasional use of alkalis. In all cases in which lateral gastroduodenostomy was performed there was satisfactory immediate convalescence. This procedure is perhaps of greatest use in cases in which it is necessary to take down a gastrojejunostomy following the formation of a jejunal ulcer and in which the lumen of the duodenum is inadequate because of old scar tissue. Excision of this old scar with the anterior portion of the pyloric sphincter muscle would be desirable but it is often impossible because of the fact that the duodenum is firmly bound down. It is not necessary to have a mobile duodenum in order to perform this type of lateral gastroduodenostomy. Furthermore the risk of the procedure is minimal.

A review of operations performed at the clinic during the past year for duodenal ulcer shows an increasing proportion of pyloric procedures in comparison with gastrojejunostomies, about 1:2. In less than 5 per cent of all of the cases was it necessary to carry out a gastric resection. This shows the attempt that is being made to maintain the normal physiological condition and to avoid the radical procedures which, in the light of our experience seem unjustified and many times, turn out to be unsatisfactory. For older patients with marked obstruction but without excessive gastric acidity gastrojejunostomy still remains the procedure of choice in most instances. In other cases local excision of the lesion with the anterior two-thirds of the pyloric sphincter muscle offers the best chance of relief whenever the operation can be carried out.

We feel that it is best to treat gastric ulcer as a surgical problem. We are willing to grant that gastric ulcer may likewise be made to subside by a medical regimen but we still contend that it is impossible to distinguish between the benign and malignant gastric ulcer without an opportunity to study tissue

of the lesion microscopically. If it were possible to have all patients with gastric ulcer under close observation at frequent intervals we might feel justified in offering a trial of medical management in those in which we have reason to feel the lesion is benign. There is no question but that the symptoms resulting from gastric ulcer can be relieved more readily through this plan than are those of duodenal ulcer. For a number of years we have recommended surgical treatment to practically all patients with gastric ulcer but it should be stated that when we carry out the operation it is a conservative plan of procedure. Some of the most satisfactory results that we have obtained in the treatment of gastric ulcer have followed this plan of caring for the condition usually a V-excision of the lesion combined with gastrojejunostomy. In these cases, the operation is practically never followed by the formation of a stomal jejunal ulcer which is the bug bear of operations for peptic ulcer. In some instances, when operating for gastric ulcer the technical procedure is simplified by taking out the pyloric part of the stomach with the ulcer and we have also used this method.

The more we study the problem of peptic ulcer the more we are impressed with the fact that an ulcer in the stomach imposes a problem very different from that of ulcer of the duodenum from an experimental standpoint as well as from the clinical and the surgical standpoint.

Finally it may be stated that we believe that some of the problems associated with peptic ulcer are worked out. From meager beginnings 50 years ago to the present time the efforts directed toward the treatment of peptic ulcer have met with a constantly increasing measure of success. As yet we have no single procedure that is applicable to all cases, but we do have well established plans of treatment of proved worth. These are rational conservative measures and when properly carried out in the treatment of the conditions for which they are intended they afford satisfactory relief from the distressing syndrome of peptic ulcer.

It is known that there are some patients who have a stronger potentiality for ulcer

than others. The best that can be accomplished for these individuals is to modify their symptoms through a restricted regimen so that they will be able to carry on their ordinary daily routine of activities.

The tremendous amount of experimental work that has been done on the ulcer problem all tends to show the importance of the concentration of the acid as a factor in the production and persistence of the ulcer. While recognition of this feature gives us something to work upon it does not at present offer as much assistance as we should like in the control of the acid factor.

We have two procedures which remove more of the recognized etiological factors than the others: lateral anastomosis between the stomach and the first portion of the duodenum and excision of the cap of the duodenum with the lesion and the anterior two-thirds of the pyloric sphincter muscle with closure as gastroduodenostomy. We think that these

procedures have more of a physiological basis and that they are more practical than any anastomosis between the stomach and the jejunum. There is wider distribution of the food stream and reduction of physical trauma, the stomach empties more rapidly and the gastric pressure is lowered. In addition the acid contents of the stomach are emptied into the most alkaline portion of the duodenum which is best fitted to care for this acid medium. Furthermore the alkaline duodenal content may easily be regurgitated into the stomach. These two operations should be employed more often.

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THE PROBLEMS INVOLVED IN THE TREATMENT OF COMPOUND FRACTURES

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THE increasing number of compound fractures that are occurring in this machine age and the divergent opinions among teachers and writers relative to the basic principles involved in their treatment impels one to believe that there is a real need for a wider discussion and a better universal agreement as to what constitutes the most approved methods of caring for these frequent and serious conditions.

It is thought by some that the radical variance of opinion regarding the treatment of compound fractures is due in a large measure to the advent of the orthopedists into this field of endeavor for by tradition and training they are not operating surgeons and the care of these cases requires broad surgical experience and judgment. The orthopedists however should be welcomed into this department of surgery the treatment of fractures, for they have added and will continue to add much to our knowledge of the entire subject. They are becoming operating surgeons.

The circumstances in the practical situation are such that the larger number of compound fractures are seen first and frequently cared for by general practitioners and this group of men are expecting the teachers and the men with the opportunities for the observation of a large number of these cases, to draw deductions and conclusions regarding the best methods of procedure for their guidance. The course must be charted for them.

A compound fracture as a surgical entity must be considered first from the pathological standpoint. Correct treatment cannot be applied without an intimate knowledge of the anatomical disturbance and an appreciation of the immediate and remote histopathology resulting from the injury.

The fracture itself is frequently of secondary importance to the trauma inflicted upon the soft tissues. Nerve blood vessel muscle and tendon injuries may demand the essential consideration in the question of treatment.

Formerly a larger proportion of compound fractures occurred in railroad accidents and from contact with heavy machinery. In these cases the crushing of the soft tissues was more extensive than it is in the many automobile injuries which are seen so frequently at the present time. In any consideration of the pathology of the fragments of the fractured bone itself it may be stated broadly that except for the potentialities of infection, the condition is not materially different from that in simple fractures.

The mechanism of the injury to the soft parts and the opening of the skin is important for in the cases compounded from within outward infection is less apt to occur and the integrity of the circulation of the soft structures is less interfered with. In a word there is less crushing of tissues. The question of the pathology concerned in compound fractures, from the standpoint of the surgical therapy that shall be applied resolves itself into a consideration of the circulation in the injured structures and their subsequent viability. Obviously our main objective is to convert a compound fracture into a simple one and this can be accomplished only if and when, we succeed in preventing infection and subsequent suppuration. Devitalized tissue offers no resistance to infection and must therefore be removed by the most careful and painstaking excision. It is rather elementary to recall how rapidly organisms on the surface extend through the lymphatics to deeper tissues and to the neighboring lymph glands, and yet an understanding of this is most essential in the treatment. Fascia and tendinous tissue having poor circulation are prone to sloughing when infected.

The muscles are apt to be our chief concern because of their size and proximity to all fractures, but fortunately their viability can be determined more easily than that of other tissues. Devitalized muscle is gray in color. It does not contract when picked up in a

forceps, and it does not bleed when cut. It is difficult to ascertain accurately the amount of blood supply in injured nerve tissue or tendon and in an estimation of their viability one must depend upon their general appearance. In any attempt to determine the amount of injury to the tissues that may subsequently be encountered careful examination should be made of the larger blood vessels supplying the distal parts.

In a large proportion of instances compound fractures occur during accidents on the high ways or on railroads and the problem of transportation to the nearest hospital is of first consideration. The Fracture Committee of the American College of Surgeons have made real progress in their practical teachings of the necessity of splinting all fractures before transportation so that the fragments will not do further damage. This point applies in particular to compound fractures. Much can be accomplished by teaching first aid to all men who are likely to come in contact with these cases. In so far as practical the Thomas leg and arm splints should be provided. The Fracture Committee have gone into this subject most thoroughly and are enlarging their educational program.

When the patient reaches the hospital he is usually in a state of shock more or less severe and this condition demands our first attention almost without exception morphine should be administered immediately as the best agent to stop pain and thus aid materially in preventing further shock. Active hemorrhage should be looked for and checked at once. All constrictors must be removed as soon as feasible. The degree of the shock must be determined and if severe no operative procedure should be considered until this is overcome. Many fatalities occur as a result of too early operation. Our first duty therefore should be to alleviate shock and any operative interference should be postponed until recovery from this primary condition has taken place. Morphine, external heat, hot coffee per rectum, hot drinks and blood transfusion when indicated offer the best agents with which to combat shock. The subcutaneous or intravenous injection of normal salt solution should not in our judg-

ment be done. Gum acacia or other similar preparations should not be given intravenously for they are of questionable value. It is appreciated that these are rather broad statements especially as regards salt solution and may cause controversy but they are our conclusions based on a rather large experience in Cook County Hospital, Chicago and in France.

As soon as the patient rallies from shock the injured limb should be given our immediate attention for the time element between the receipt of the injury and the treatment of the wound is most important. Almost without exception operative interference is indicated. It is assumed that head, chest, abdominal or other injuries do not preclude operation on the limb.

The choice of anæsthetic must depend upon the judgment of the individual operator although it is our conviction that no single method should be employed routinely for every case. Nitrous oxide and oxygen and ether by the drop method are preferable. Possibly spinal anæsthesia is desirable for thigh injuries in the hands of those accustomed to its use.

Continuing the question of the treatment let us assume that the circulation of the distal part is such that the necessity for immediate amputation has been excluded. With the patient asleep the problem of cleansing the wound confronts us. Water and green soap are used following shaving, for cleansing the surrounding skin. This is done after protecting the wound with gauze. After the skin is prepared with soap and water ether is used to remove all grease and other soiling.

Then comes the question of the choice of antiseptics, if any are used. Does not the multiplicity of the antiseptics now in use condemn them all as dependable agents? We believe it does. Some antiseptics may be capable of destroying organisms on the surface but they serve no useful purpose in attacking the bacteria deep in the structures and we are convinced that most of these so called germicides further lower the resistance of the almost devitalized tissue when applied in sufficient quantity and concentration to be of any value. They should not be relied upon

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THE increasing number of compound fractures that are occurring in this machine age and the divergent opinions among teachers and writers relative to the basic principles involved in their treatment impels one to believe that there is a real need for a wider discussion and a better universal agreement as to what constitutes the most approved methods of caring for these frequent and serious conditions.

It is thought by some that the radical variance of opinion regarding the treatment of compound fractures is due in a large measure to the advent of the orthopedists into this field of endeavor for by tradition and training they are not operating surgeons and the care of these cases requires broad surgical experience and judgment. The orthopedists, however, should be welcomed into this department of surgery, the treatment of fractures, for they have added and will continue to add much to our knowledge of the entire subject. They are becoming operating surgeons.

The circumstances in the practical situation are such that the larger number of compound fractures are seen first and frequently cared for by general practitioners, and this group of men are expecting the teachers and the men with the opportunities for the observation of a large number of these cases, to draw deductions and conclusions regarding the best methods of procedure for their guidance. The course must be charted for them.

A compound fracture as a surgical entity must be considered first from the pathological standpoint. Correct treatment cannot be applied without an intimate knowledge of the anatomical disturbance and an appreciation of the immediate and remote histopathology resulting from the injury.

The fracture itself is frequently of secondary importance to the trauma inflicted upon the soft tissues. Nerve, blood vessel, muscle and tendon injuries may demand the essential consideration in the question of treatment.

Formerly a larger proportion of compound fractures occurred in railroad accidents and from contact with heavy machinery. In these cases the crushing of the soft tissues was more extensive than it is in the many automobile injuries which are seen so frequently at the present time. In any consideration of the pathology of the fragments of the fractured bone itself it may be stated broadly that, except for the potentialities of infection, the condition is not materially different from that in simple fractures.

The mechanism of the injury to the soft parts and the opening of the skin is important, for in the cases compounded from within outward infection is less apt to occur and the integrity of the circulation of the soft structures is less interfered with. In a word there is less crushing of tissues. The question of the pathology concerned in compound fractures, from the standpoint of the surgical therapy that shall be applied, resolves itself into a consideration of the circulation in the injured structures and their subsequent viability. Obviously our main objective is to convert a compound fracture into a simple one and this can be accomplished only if and when, we succeed in preventing infection and subsequent suppuration. Devitalized tissue offers no resistance to infection and must therefore be removed by the most careful and painstaking excision. It is rather elementary to recall how rapidly organisms on the surface extend through the lymphatics to deeper tissues and to the neighboring lymph glands and yet an understanding of this is most essential in the treatment. Fascia and tendinous tissue having poor circulation are prone to sloughing when infected.

The muscles are apt to be our chief concern because of their size and proximity to all fractures, but, fortunately, their viability can be determined more easily than that of other tissues. Devitalized muscle is gray in color, it does not contract when picked up in a

lived favorites which lost their popularity rapidly. They did not withstand the test of time. During this time in France when wounds were drained it is not recalled that we ever saw a clean non-infected wound. In 1918 all of this was changed and débridement was practiced extensively in the advanced stations and following this procedure many of the wounds were closed without drainage, and later under observation in the base hospitals they remained clean. Then we began to experience the satisfaction of seeing compound fractures converted into simple fractures and recover without suppuration. The accuracy and completeness of the skin suture must depend upon the loss of superficial tissue substance and the circulatory integrity of the remaining skin flaps. Obviously any portion of skin that is thought completely deprived of all of its circulation must be sacrificed. Generally, it is not good practice to undermine the edges of the skin to overcome tension. Occasionally it is feasible to make longitudinal incisions a distance from the edges to facilitate their apposition. The sutures should always be tied loosely and at some distance apart so as to allow the escape of fluids that might collect and cause considerable tension. A thought that the collection of serum may act as a germicide has been advanced. Where the skin has been so destroyed as to preclude the approximation of the edges a full thickness flap may be implanted over a small area. If it is found impossible to secure by any means an entire skin covering it is our practice to apply a dressing of equal parts of alcohol and glycerin. This dressing is hygroscopic and tends to promote the flow of lymph toward the surface—a process thought to be beneficial.

We are in accord with the older school of thought which teaches that the long muscles of the extremities immediately contract and subsequently retract when a bone or bones are fractured. Following this conception we always apply skeletal traction to the distal part and this is usually accomplished by means of some form of caliper or bone clamp. Kirchner's wire or some other device may be used. The caliper in some form seems preferable for it does not penetrate the substance of

the bone and is more easily removed. However this may be decided by the choice of the individual surgeon. Plaster-of-paris splints or casts are rarely used. Perhaps they have a function in selected cases. Dependence is placed upon suspension splints, preferably some type of Thomas splint or the various modifications. New splints are being constructed by men of ingenuity and many of them have merit but give the best results in the hands of their designers. This is a technicality that is not important if the principle of skeletal traction is carried out.

The danger of tetanus and Welch bacillus infections in compound fractures is common knowledge and a prophylactic dose of anti-tetanic and anti-Welch bacillus serum should be given as routine practice.

An attempt has been made here to give the principles of a routine method for the treatment of compound fractures of all kinds. If some of the statements seem dogmatic may we say that they are predicated upon a rather wide experience and advanced with a knowledge that any broad assertions about the surgical therapy best adapted for these cases, must be qualified by the admission that each injury has particular conditions with which to deal and is a law unto itself.

SUMMARY

- 1 All fractures must be splinted before transportation when this is practical.
- 2 The first procedure must consist of efforts to combat shock.
- 3 Débridement must be depended upon to cleanse the wound—mechanical and not chemical sterilization.
- 4 Careful search should be made for all severed nerves and tendons and repair accomplished.
- 5 Perfect hæmoëstasis must be secured.
- 6 It is imperative that all drainage materials be completely avoided.
- 7 The skin edges should be accurately approximated when possible.
- 8 Skeletal traction should be applied for the retention of the fragments in anatomic apposition.
- 9 Suspension rather than plaster-of-paris splints should be used.

ADEQUATE BACTERIOLOGICAL SERVICE FOR A SURGICAL DEPARTMENT

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THE era of modern surgery is hardly more than half a century old. It began within the life time of many of the leaders of our profession and within the span of the professional careers of those older practitioners who are reaching the years of retirement and reminiscence. In another decade we shall no longer be able to hear the tales of surgical practice before the days of Pasteur and Lister. Modern surgery is founded upon certain bacteriological laws and its scope would have remained greatly limited if it had not made practical application of that biological knowledge out of which also grew the science of bacteriology. The discovery of these laws we owe to Pasteur. Their practical application to surgery we owe to Lister. Pasteur discovered that infection of wounds is caused by bacteria and Lister demonstrated that these bacteria may be destroyed by appropriate means and that the infection of operative wounds may thus be prevented.

One would have supposed that the science and art of modern surgery having established itself on these basic bacteriological laws, would have continued to be intimately wedded to the science of bacteriology so that they might have grown up together to their mutual benefit but such is not the case for in most hospitals and in many medical schools they have been completely divorced. Each goes its own way with little or no recognition of the other and with little or no attempt at mutual aid. If you should ask the chiefs of the surgical staffs of our hospitals, or the professors of surgery in our medical schools if they have anyone in their departments particularly interested in bacteriology or if you should ask the professors of bacteriology if they have anyone in their departments particularly interested in surgery or surgical problems, the answer in the majority of cases, would be 'No.' This is not true of the departments of medicine for in most hospitals and medical schools the members of the bacteriological

departments are often particularly interested in medical problems. Very often the head of the department of medicine is an expert in infectious diseases, and those members of his staff who are interested in bacteriology equal in numbers and rank those interested in the metabolic disorders.

One is tempted to ask why this should be so. Is there a larger proportion of infectious diseases in medical practice than in surgical practice? This may be true, but if this is a factor I doubt if it is the important one. The practice of surgery requires a large proportion of time to be given to certain technical training which the medical man does not need. Likewise the surgeon must devote longer hours to the detailed study and to the frequent review of anatomy. For many years many young surgeons considered it a necessary part of their training to teach anatomy. The next requirement for the surgeon is to know pathology. In this respect he does not differ from the medical man although it may be said that the surgeon more often has an opportunity of studying the pathology of his cases because such examinations can be made in all of his cases, those which survive as well as those which die while the medical man's pathological study is limited to those cases which go on to a fatal termination of the disease. What time has a surgeon left to study bacteriology or be interested in it? The obvious answer is—None, he must depend upon the bacteriologist to do his bacteriology for him. But can a bacteriologist, without knowledge of surgery give adequate service to the surgeon either for routine or for special work? This question must be asked of the head of the surgical service or department. Are you satisfied with the service the bacteriological department is giving you? If we meditate upon this question it becomes evident that this service must be fourfold: (1) routine, (2) emergency, (3) special minor research, and (4) major research.

THE PROBLEM

Routine work In the first place there is a great mass of routine service to be rendered—the periodic check up of the operating room technique—the autoclaves the instrument sterilizers the water sterilizers the antiseptics the catgut the ward dressing technique the cultures of infected wounds abscesses carbuncles empyemas sore throats, urine and other material obtained from the daily run of operative cases and ward dressings. This work is perhaps the easiest to handle. It can be done in the course of the day's work from nine until five and a large mass of material may be handled at the same time.

Emergency work In the second group which is perhaps more important, there is a great quantity of work which might be called emergency bacteriology. This must be done on short notice at any time of the day or night. A patient comes into the hospital with peritonitis. The surgeon operates and finds a large amount of free peritoneal fluid without any evident perforation of the gut. He should know as soon as possible the nature of the infection. A smear and an immediate examination of the stained slide must be made while he is still operating and cultures must be made at once so that he may know within the time of brief incubation the organisms involved. Or a patient comes in with a compound fracture and after it has been set up with the proper traction and suspension apparatus, suddenly in the middle of the night the temperature goes up and the patient complains of pain in the wound. It is found to be swollen oedematous a little dusky. There is doubtful crepitation of the tissues. The surgeon must know promptly from smear and culture whether the gas bacillus is on a rampage and which of the four varieties is present. A patient has been operated upon for a pyloric obstruction a gastro-enterostomy has been done cough and hiccough are annoying postoperative complications. Suddenly in the night he develops pain in the wound. An examination reveals puffiness and crepitation beneath the wound. The surgeon must know at once whether a gas infection has developed or gas from a perforation or leak has appeared in the wound. A quick bac-

teriological examination is necessary. A patient comes in with a high fever he is obviously septic, the focus is not apparent but it is important to know as soon as possible whether or not the patient has a positive blood culture. A patient is admitted to the hospital with high fever and a swollen painful, red hot knee-joint. The surgeon aspirates the fluid and needs to know the nature of the infecting organism by smear and culture. Any delay will materially affect the promptness of treatment and the eventual outcome. A patient is admitted with signs of fluid in the chest, aspiration reveals a thin, turbid fluid. Is it transudate or exudate? What bacteria are present? The correctness of treatment depends upon the prompt answer to these questions. Is your bacteriological department prepared to give you this emergency service at any time of the day or night?

Special bacteriological minor research Frequently a patient comes into the hospital who presents an unusual problem in surgical infection. It may be an unusually severe type of a well recognized infection or a rare type not easily recognized. The case obviously needs some special bacteriological study. Routine methods of taking specimens or routine methods of cultivation will not suffice. The preliminary culture may reveal no organisms in a lesion which is obviously an infection, or it may reveal an unusual organism with peculiar properties which require further study or it may yield a mixture of organisms, only one of which is significant. Such problems come up in severe cases of septicæmia in which not only the diagnosis must be made but the course of the disease must be followed from day to day. Serious involvement of the face and neck following the spread of an infection from teeth tonsils or oesophagus require this special kind of bacteriological service for here we may have a mixture of mouth organisms and the severity of the infection may be due not so much to any single species of organism present as to the synergism of the various species. Such complex problems likewise arise in cases of acute or chronic infective gangrene of the skin and these may have to be handled not only by means of a special bacteriological analysis but they may require

a series of animal experiments before the nature of the infection can be determined and the problem satisfactorily solved. Cases of lung abscess or bronchiectasis require a complete bacteriological analysis before they can be intelligently handled. Liver abscesses frequently need to be studied from several different angles before the cause can be determined and the appropriate treatment applied. Chronic ulcers of the abdominal wall or of the extremities often present difficult bacteriological problems which cannot be solved by simple procedures. Certain extensively infected wounds with loss of substance such as were seen frequently in time of war and occasionally occur in cases of accident require not only an analysis of the original bacterial flora but a periodic examination to determine when the various organisms disappear and when it is safe to subject the wound either to skin graft or secondary closure. For a failure to consider the bacteriological elements in such a problem may result in a failure of the surgical procedure. Such special studies of individual cases as I have described may be called minor research in surgical bacteriology and unless these unusual problems are satisfactorily solved the bacteriological service cannot be called adequate.

Major research. Besides the minor researches which may be required in connection with any individual case there are certain major or perennial problems in bacteriology in which surgeons should be interested. Some of these they very properly share with the internist for example pneumonia. Although the pathogenesis of postoperative pneumonia may have a different mechanism from ordinary pneumonia, the bacteriological aspects may very well be the same in both cases. Lung abscess and empyema are of interest both to the medical and surgical services but here it must be admitted that the surgeon is more directly concerned. In like manner both surgeon and internist are involved in bacterial problems associated with the alimentary canal. The internist is most concerned when the disease is due to a disorder caused by the organisms while remaining within the tract, while the surgeon becomes particularly interested when the intestinal organisms invade the tissues

outside of the alimentary tract for example, in peritonitis, cholecystitis, cholangitis, pylophlebitis, etc. Arthritis may be a problem in which the internist is more concerned but when it becomes a suppurative process the surgeon must take a hand. The surgeon is taking more and more interest in the disease of the peripheral blood vessels more perhaps from the point of view of the vasomotor nervous mechanism than from the bacteriological point of view but we still have the problems of suppurative phlebitis, postoperative thrombophlebitis with pulmonary embolism, migrating phlebitis and thrombo-angitis obliterans which have not yet been satisfactorily studied from a bacteriological viewpoint. Bacteriophage was originally studied intensively in connection with such internal infections as dysentery and cholera but it has been more recently applied to surgical diseases such as furunculosis, carbuncles, subcutaneous abscess and septicemia. Here is a new attractive and intensely stimulating field in which surgeons with wide clinical experience may profitably expend their powers of observation and experimentation. Septicemia, in its multitudinous aspects needs continuous and intensive research before its problems can be solved. Bacteriological problems both medical and surgical very easily lead to more fundamental problems in immunity both general and local. Indeed the problems of local immunity may be of greater interest to the surgeon than the problems of general immunity because his problems are usually local and his treatment must necessarily be limited to a relatively small region or a single tissue or organ of the body.

From the statements so far made it is obvious that the problems which face the surgeon from the bacteriological viewpoint are legion. They crowd in upon him from every side and in most clinics and in most hospitals they are either not faced at all or are assigned to those who are not particularly interested or are not qualified to reach a satisfactory solution. If every professor of surgery or the surgical director of every hospital were asked if he were satisfied with the bacteriological service which he is receiving one wonders how many could conscientiously answer "Yes."

THE SOLUTION

If there is to be any solution of this problem it must come not from the bacteriologists but from the surgeons themselves. It is difficult for a bacteriologist to attack a surgical problem for it is almost impossible for him to acquire a surgical point of view without surgical training. These problems must be attacked by surgeons who have developed the surgical viewpoint and in the course of their training have acquired the fundamental knowledge of bacteriology. They may then apply it to the surgical problem. Pasteur did not solve the problem of aseptic technique but Lister, the surgeon, learned the fundamental laws of bacteriology from Pasteur and applied them to a surgical problem. The professor of surgery or the surgical chief cannot go to the professor of bacteriology and say "Here are our problems of infection please solve them for us." He must say to his internes and his staff "Learn the fundamentals of bacteriology and apply them to our problems of infection in surgical conditions." A large part of the time given to train a surgeon must be spent in acquiring the manual dexterity needed to perform operations. Similarly a large proportion of a surgeon's time each day must be given to the actual surgical treatment of his cases. A certain technique is also necessary in bacteriological work but this is more easily acquired and the actual problems are solved more by reading, thinking, observing, correlating and co-ordinating than by the actual performance of experiments.

However, for the solution of the difficulties arising in any particular hospital only general principles can be laid down. These must be adapted and applied to the peculiar situations which are found in different institutions. The professor of surgery, or the surgical director, must make such arrangements as the size and quality of his staff will permit and the results will depend on the amount of time and intelligence applied to his bacteriological problems. It would seem fundamental that the surgical internes should have as part of their regular training at any convenient period in their rotary service the responsibility for doing the routine and emergency bac-

tenology of the surgical department. They must have supervisory instruction from the staff bacteriologist or from one of the surgical department who has been trained in bacteriology. The former is preferable for the staff bacteriologist is more apt to be able to develop a broader bacteriological viewpoint. Furthermore, at night or on holidays the surgical internes may be required to do the emergency bacteriology for the medical service just as the medical internes may be called upon in emergency to make cultures from surgical specimens. If the surgical internes are required to do the bulk of the routine and emergency bacteriology for the surgical department, the surgical viewpoint will be brought to the study of the specimen. Instead of having the specimen studied in a routine and perhaps abstract way as "pus" it will have a more particular interest in being a special kind of pus from a known location in a particular individual. In such a case the report is much more apt to be of some significance. During this period of bacteriological study and service this work need not be the internes' only duty, but it should be paramount and should be performed as the most important duty of the day. In cases of emergency he must be available to receive and cultivate the material as soon as possible after it is obtained from the patient. No time must be allowed for the material to dry and yield nothing on culture when viable organisms are really present in the material when it is obtained. The period of the interne's service must be long enough for him to learn all of the bacteriological methods including anaerobic as well as aerobic culture, fermentation and proteolytic reactions, special media and methods for special organisms, animal inoculation, immunological reactions, vaccine and serum preparation, complement fixation and agglutination tests. This training will arouse his interest and give him the groundwork necessary for further studies when he has completed his internship and has advanced to a higher rank in the staff. If time permits, the interne may assist in the special studies or major research under the direction of one of the older members of the staff and this will increase his interest in

and give significance to his routine and emergency duties.

The special intensive study of a single interesting case can best be carried out by one of the resident or attending members of the staff who is not deluged by routine duties and can have some time to read, study, think, correlate, and apply his knowledge of fundamental bacteriology to the problem in hand. The clinical care of the case need not necessarily be in his hands but there are many things to be said in favor of this arrangement. He is able to apply the treatment indicated without delay; his hands are not tied by a contrary opinion with regard to the treatment. The patient has the advantage of an individual doctor's responsibility for his case. Any change in the patient's condition is noted early and appropriate measures taken to investigate the cause, etc., etc. Such special investigations should be limited to the particular case and enlarged only if they are found to lead to general principles which require the carrying on of research on a larger scale.

The major or perennial problems of surgical bacteriological research should always be under close direction of one of the older men who has had both the clinical and technical experience necessary for its solution or intelligent attack. Such studies must be correlated and carried through in a logical fashion—a part at a time but with the part seen in its relation to the whole. In these problems the director of research may have technical help but the results obtained by such assistants must invariably be checked by his own obser-

vations and he must constantly correlate the various parts of the problem and hold the investigations to the main purpose.

As to the question of how far such researches should go in the direction of pure science there may be a real difference of opinion. This may depend upon the number of members of the staff available for such work. If there are many, one individual might be assigned to certain abstract phases of the problem but it would seem to be better to leave such aspects of the problem to a regular member of the bacteriology department who might have better qualifications to carry it to a successful solution.

CONCLUSIONS

An adequate bacteriological service for any surgical department directs its attention to routine work, to emergency work, to special research, and to general research. This service can be obtained only when the professor of surgery or the director of the surgical service demands the necessary money and equipment from the authorities and lays out a plan for the training of internes in bacteriological technique, and builds up into his own staff those qualified to carry on minor and major research in the bacteriological problems of surgery.

After many nuclei of such work have been developed in many medical centers friendly rivalry will speed the solution of these problems and it may be possible to correlate or subdivide the problems in some way so that the best service may be obtained with a minimum of wasted time and energy.

TUBERCULOUS TENOSYNOVITIS OF THE HAND

A STUDY OF THIRTY THREE CASES OF CHRONIC TENOSYNOVITIS OF THE HAND¹

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THE present study of tuberculous tenosynovitis of the hand can lay claim to little of originality. The report of Dr Kanavel in 1923 has described the condition so well that additions are superfluous and deletion impossible. In the account which follows I have borrowed heavily from Kanavel and am glad to acknowledge the indebtedness.

The material upon which this report is based consists of 32 operated upon cases of chronic tenosynovitis of the hand from the service of Drs Allen B. Kanavel, Sumner L. Koch and myself at Wesley Memorial and Passavant Memorial Hospitals, Chicago, they represent a period of observation of over 20 years, the first patient having been operated upon in 1914. Of the 32 cases, 23 are verified tuberculous tenosynovitis and it is upon these that this paper is essentially based. The 9 remaining of the 32 patients include 3 instances of multiple tenosynovitis, none of which was definitely proved to be tuberculous, and 6 instances of chronic tenosynovitis clinically indistinguishable from the tuberculous type.

Tuberculous is the most frequent cause of chronic infection of the tendon sheaths of the hand. Because of the slow development and the not infrequent absence of pain or functional disturbances until late in the course of the disease the tendency for both patient and surgeon is toward delay in seeking or in administering adequate treatment. Frequently the correct diagnosis is not made for many months or even years with consequent loss of valuable time. The presence of a chronic dough-like sausage-shaped swelling over the flexor or extensor tendons is practically always due to tuberculosis and if rice bodies can be demonstrated the diagnosis is practically certain. Despite the chronicity early recognition of the nature of the disease is necessary if we are to treat it successfully since, if the condition progresses, the tendons themselves are invaded and may be destroyed and fistulae,

secondary infection, and extension to bones and joints are apt to occur. The possibility of a complete cure is attested by the results from our clinic and numerous other surgical clinics.

ETIOLOGY

It is usually stated in the literature that tuberculous tenosynovitis is somewhat more frequent among males than females, according to Zieppritz in the proportion of males to females of 3:2. Clairmont, Winterstein and Dimitra of 62 patients found 30 males to 32 females, while our own figures are 9 males to 14 females.

The age incidence shows a predilection for the third and fourth decades, though no age is exempt. Our own figures of 23 cases show a fairly even distribution for the male patients from the second to the sixth decade, while the female patients reveal a very definite preponderance in the third decade.

TABLE A—AGE INCIDENCE OF TUBERCULOUS TENOSYNOVITIS

Decade	Personal cases (Kanavel, Koch, and Mason)			Clairmont et al	Total
	Male	Female	Total		
0-10	0		0	3	3
1-20		3	4	3	10
2-30	3	8	11	13	4
3-40	1	1		7	0
4-50	3	0		13	13
5-60			4	7	11
61-70	0	0	0	3	3
7-80	0	0	0	1	1
81-90	0	0	0	1 (84 years)	1
Total	9	14	23	62	85

In our cases the age is taken as the age of onset and not the age at which patient applied for treatment.

The youngest patient upon whom we have operated for this condition was 19 years of age and the symptoms had been present some 6 months at the time. However another

patient who came for treatment at the age of 23 gave a history of swelling of the wrist and fingers of 10 years duration which indicates an age of onset of 13 and would make her therefore the youngest in our series. The oldest patient was a female of 60 whose disease began 18 months before operation, i. e. at about the age of 58. Clairmont, Winterstein and Dumita report 2 cases in the first decade and 1 in the ninth decade (82 years). The average age of onset in our patients is 32.6 years with the average for the male patients of 37.9 years and for the female patients of 29.1 years. We can suggest no explanation for this difference in age distribution.

The disease shows a rather definite predilection for the right hand (16 right and 7 left) and for the volar surface (18 volar, 4 dorsal, 1 both volar and dorsal). In the 14 cases reported by Dr. Kanavel in 1923 the right hand was involved in 13 and the left in 1, the latter in a left handed individual. We do not know however that the 13 others were right handed and we do not know how many of the present series are right handed though the preponderance of involvement of the right hand may be of some significance.

What rôle occupation plays is uncertain. It is usually stated that those who use their hands for manual labor are most frequently victims of tuberculous tenosynovitis. The occupation of housewife occurs in 8 of the 14 females while the 6 others are nurse, saxophone player, laundress, clerk, beauty parlor operator and club executive respectively. Of the 9 males, 2 were clerks, 1 was a clergyman, 1 a banker and 1 a nightwatchman. The 4 others used their hands for hard manual labor: shoemaker, farmer, mechanic, and coal miner. Hence although it is usually conceded that manual labor predisposes to the infection, other factors are undoubtedly of equal importance.

Whether the rate of intimate exposure to tuberculosis is higher among these patients than among any other group of patients we cannot say. Of 23 patients, 5 (1 male and 4 females) gave a definite history of tuberculous contacts, i. e. with members in the immediate family with active (usually fatal) tuberculosis.

Eleven patients denied any exposure among the immediate family, while in 7 information is lacking. Of the 5 patients with history of exposure 2 subsequently succumbed to tuberculosis.

In 6 instances evidence of other possible tuberculous lesions elsewhere on the body was present. In 1 patient there was an active pulmonary tuberculosis which eventually proved fatal. Another succumbed to a laryngeal tuberculosis. In 1 case a small skin nodule which proved to be tuberculous was excised from the forearm, and in this patient some diminished resonance and fine crepitant râles in the right apex were suggestive but never conclusive of pulmonary pathology. In another case cervical lymph glands broke down and drained for 5 months after excision of the tuberculous tenosynovitis. In the 2 others tuberculosis was not proved and the evidence therefore was scanty. In 1 instance there was a history of loss of weight and a pleurisy while physical examination revealed some suggestive findings in the right pulmonary apex consisting of some impaired resonance slightly increased vocal and tactile fremitus and prolonged expiratory sound. There was some slight cervical adenitis. The X-ray examination of the chest showed some peribronchial thickening but no apical involvement. In another patient there was a history of pleurisy without effusion which lasted for 3 weeks some 10 months previous to the onset of the tenosynovitis. There were however no abnormal findings in the lungs.

The question of trauma is an interesting one. Although 11 of the 23 patients gave a history of trauma an analysis of these cases leads one to doubt trauma as an etiological factor in all but 3 while in the others the connection between trauma and tenosynovitis is too indefinite, the period elapsing between injury and tenosynovitis is too short, or the history is of an open injury and the source for an inoculation infection is not clear.

In 1 case the patient was cranking a car when the crank came loose and the patient fell on his outstretched right hand and wrist. Immediately after this accident he experienced considerable pain and swelling over the dorsum of the fourth and fifth metacarpals which

lasted several days and subsided completely. About 8 months later a swelling appeared on the dorsum of the wrist which gradually increased in size to that of an egg. There was no spontaneous pain when the tumor appeared and there had been no pain except on use of the wrist. An X ray examination made at the time the patient came for treatment showed involvement of the radius. A typical dorsal tuberculous tenosynovitis was found at operation and proved to be so microscopically.

The second patient in whom trauma might be a definite factor also with positive histological proof of tuberculosis, suffered a sprain of the wrist about 1 year previous to the onset of the tenosynovitis. This was also a dorsal tuberculosis, and the first symptom was swelling. Pain here was not spontaneous nor was it present on use of the wrist.

In a third patient trauma must also be considered of possible etiological importance. The patient stated that she had pounded with the palm of her hand upon an ice pick following which there was considerable swelling of the fingers. Several months later a puffy swelling appeared in the palm and later above the wrist associated at times with considerable pain. Symptoms and findings persisted despite various sorts of conservative treatment for 8 years. At operation there was found a typical gross and microscopic tuberculous tenosynovitis of the flexor pollicis longus sheath and common flexor sheath at the wrist.

In 3 other instances although a trauma



Fig 1. Tuberculous tenosynovitis of radial and ulnar bursae with extension into the digital prolongations of the thumb and little finger. Involvement of the digital sheath of the index finger, complete destruction of both flexor tendons to the little finger and invasion of the flexor tendons to the index finger and thumb.

preceded the onset of the tenosynovitis the sequence of events was too rapid to admit any causal relationship. Thus in one instance a severe sprain of the wrist in a mechanic was followed at once by a tuberculous tenosynovitis of the dorsum of the hand. In a second patient a rock fell upon the wrist and this was followed almost at once by an extensive tuberculous tenosynovitis of the volar sheaths. In a third a mild trauma to the dorsum of the hand was followed in 24 hours by a tuberculosis of the radial and ulnar bursae and the sheath of the index finger. In 2 others the trauma if such there were was so slight as to be only imperfectly remembered by the patient. In this connection however it is interesting to note that none of 6 patients with chronic tenosynovitis in which the microscopic sections failed to bear out the clinical diagnosis of tuberculosis gave a history of trauma.



Fig 2. a, b, c, Tuberculous tenosynovitis of digital sheath of right index finger. d, e, Tuberculous tenosynovitis of digital sheath of right middle finger. f, g, Tuberculous tenosynovitis of digital sheath of index finger. The

patient had been operated upon 6 years previously for tuberculosis of radial and ulnar bursae, which were excised and there was no recurrence. The index sheath involvement eventually invaded bone, necessitating amputation of finger.



Fig. 3. Tuberculous tenosynovitis of dorsum of right wrist. Pulmonary tuberculosis present. The typical spindle shaped swelling is well shown.

That tuberculosis of the tendon sheaths may follow direct inoculation of tuberculous material into the sheath is adequately attested by numerous case reports in the literature. In most cases the patients are either butchers who have slaughtered tuberculous cattle (von Tempky) and inoculated themselves accidentally with a knife or they are attendants in tuberculous sanatoria who injure themselves on broken glass sputum dishes (Muehsam). In only one of our cases was there any suggestion of inoculation. The patient first noted a soreness on the volar surface of the distal phalanx of the right thumb. This was soon followed by the development of a small nodule at which the patient picked with his pocket knife and from which pus was obtained. This infection was incised and drained, discharge continued intermittently for about a year at the end of which time the wrist became swollen. Two other patients cited cutting injuries preceding the development of the tenosynovitis. However the chain of events is not sufficiently clear to warrant a suggestion of inoculation. There was no history of handling of tuberculous material and the



Fig. 4. Tuberculous tenosynovitis of the radial and ulnar bones. The radial bursa has been removed, but recurrence has taken place in the ulnar bursa. The typical swelling is shown at the wrist and in the little finger.

patients themselves had no other tuberculous lesions.

In two instances the onset of the tenosynovitis was preceded by an acute infectious disease in fact in each instance by two acute infectious diseases. In one case there was a severe flu of 3 weeks duration during the 1918 epidemic. After the subsidence of the flu an acute polyarticular arthritis (diagnosed as acute rheumatism) developed and during this time pain and swelling occurred on the dorsum of the hand. In the other case the patient at the age of 13 contracted measles followed by pneumonia which kept her in bed for 3 months. During the time she was bedridden tenosynovitis developed and persisted for some 10 years when she came to us for treatment. At this time there was no evidence on physical examination of any pulmonary lesion.

In our experience tuberculous tenosynovitis secondary to a tuberculosis of the bones of the wrist is quite rare. In but 2 of the 23 cases did it appear possible. In 1 case the radius and in the other the ulna and triquetrum were the site of the infection and in each case the tenosynovitis was the more severe condition. We have not taken roentgenograms routinely of the hands of patients with tuberculous tenosynovitis and we do not know in just how many cases a bone lesion might have been demonstrated. However in view of the subsequent histories of our patients we do not believe the percentage would be large.



Fig. 5. Tuberculous tenosynovitis of entire radial bursa and of ulnar bursa above transverse carpal ligament. The photographs illustrate the swelling which was present above the transverse carpal ligament at the wrist and over the volar surface of the thumb.

DISTRIBUTION AS TO SHEATHS

In the majority of instances tuberculous tenosynovitis of the hand involves the volar tendon sheaths (Fig. 1). Of the 23 cases, in 19 or slightly over 80 per cent the volar sheaths were involved, in 1 of these with subsequent involvement of the dorsal sheaths. In 17 of these 19 instances the radial and ulnar bursae were involved while in 2 cases digital sheaths were affected alone, in 1 case (Fig. 2, a, b and c) the sheath of the index finger and in the other of the middle finger (Fig. 2, d and e). Of the 17 in which the radial and ulnar bursae were involved together there was infection of separate finger sheaths in 4, in 3 the sheath of the index (Fig. 2, f and g) and in 1 the sheath of the ring finger. In 3 instances this associated involvement was concurrent with the radial and ulnar bursa infection while in 1 case (Fig. 2, f and g) the index sheath did not show any evidence of infection until some 6 years after successful operative excision of the radial and ulnar bursa. It is doubtful in this case if the index finger sheath was already infected at the time of the first operation. In 2 of the 3 other cases the digital sheath was excised at the same time as the radial and ulnar bursa because objective evidence of infection was present. In the other case the patient returned 3 months after operation with recurrence in the ring finger. The sheath we assume was already infected at the time of the first operation but without clinical evidence thereof.

In 5 cases the dorsal sheaths (Fig. 3) were infected 4 times alone, and in 1 instance with



Fig. 6. Chronic non-specific tenosynovitis of radial and ulnar bursae of both hands.

associated disease in the volar sheaths and carpus. Although isolated involvement of the various dorsal synovial sheaths may occur we have always found multiple involvement. The extensor digitorum communis and extensor pollicis longus sheaths are invariably affected while the other sheaths may escape.

The extent to which the radial and ulnar bursae may be involved varies somewhat from case to case while involvement of the finger sheaths or of the dorsal sheaths practically always extends throughout the entire sheath. Thus the radial and ulnar bursae may be markedly involved at the wrist and the process may extend distally into the distal ends of the two bursae (Figs. 4 and 5). The disease process may stop in the palm and not invade the thumb or little finger at all or one may be invaded throughout its entire extent while the digital extension of the other bursa may be entirely free. The digital prolongation into the little finger most often escapes. Thus of the 17 cases in only 5 did the radial bursal prolongation in the thumb remain free of disease, while in only 5 was the digital prolongation in the little finger involved. In no case was the radial or ulnar bursa involved alone. In 1 instance in which the ulnar bursa from gross inspection at time of operation seemed free of disease, the radial bursa alone was removed. There was prompt recurrence of the trouble, this time with extensive invasion of the ulnar bursa. This observation coincides with our experience with acute purulent tenosynovitis—that infection of one bursa is in practically every instance followed by invasion of the other.

Although instances of multiple tuberculous tenosynovitis have been reported it has not

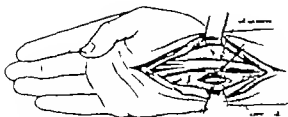


Fig. 7. The median nerve, especially within the narrow confines of the carpal tunnel, is compressed by the swollen sheath beneath it; it may be surrounded by tuberculous tissue, its surface injected and fibers separated by oedematous swelling. Actual invasion and destruction have not been seen.

been our privilege to see any such case. Three cases of multiple tendon sheath involvement have been operated upon, but in none has a tuberculous origin been proved. In each case both hands were involved—in one both the volar and dorsal sheaths; in 2 cases the volar sheaths of the right hand, the dorsal sheaths of the left and the left knee joint were affected while in the third the volar sheaths of each hand (Fig. 6). In the 2 first instances the sheaths contained a thin straw-colored fluid and a small amount of viscid gelatinous material adherent to the tendons and to the walls of the sheaths. In neither case was there any invasion or destruction of the tendons. In the third case the gross pathological picture was that of a tuberculous process and there was invasion and partial destruction of tendon tissue.

PATHOLOGY

It is customary to divide the tuberculous infections of tendon sheaths into four types: (a) serous which is very rare; (b) serofibrinous or rice body hygroma; (c) fungus; and (d) cold abscess (Kaufmann, Lexer, Mueller). This subdivision is of no particular practical value except that there seems to be a less severe involvement and less likelihood of tendon destruction in the pure hygroma or rice body type than in the fungus. Since however one type tends to pass over by insensible gradations into another and all pathological types may be present in one and the same case the distinction cannot always be made.

GROSS PATHOLOGY

The gross pathological picture presented by tuberculous tenosynovitis varies somewhat

depending upon the type or predominating type of lesion and upon the duration of the disease. Thus in very early stages the sheath may be but slightly thickened and the synovial fluid straw-colored and increased in amount while in later stages these pathological changes may progress to produce marked thickening of the sheath with granulation tissue proliferation, caseation, rice body formation, tendon invasion and destruction with secondary infection and sinus formation.

It must be constantly kept in mind that the infection involves both the parietal and visceral layers of the sheaths, and that whatever might be the contents of the sac the primary pathological focus is in the synovial wall.

The description of the gross pathological picture as given by Dr. Kanavel in 1923 can not be improved upon.

The affected area, whether it involves the dorsal or volar surface of the forearm, the wrist, the palmar surface of the hand, or the individual fingers, appears as a more or less spindle-shaped swelling (Figs. 1, 2, 3). The swelling may give a definite sense of fluctuation, it may be doughy; it is rarely hard and firm. Early in the course of the disease it may be so ill defined as to leave a question as to its actual presence.

On incising the skin over the affected area, the deep fascia appears more tense than normal, and the fascia and superficial tissues may appear slightly oedematous. On incising the deep fascia, evidence of pathological change immediately appears (Fig. 7). The tendon sheaths are no longer white, and glistening, but yellowish-white, grayish-red, gray-purple or bluish-purple.

They appear as definite separate demarcated cyst-like structures easily separable in the early stages at least from the surrounding structures. Occasionally large veins course over the mass and with the purple coloration which is often present suggest an angioma. At times in the early cases of hygroma areas of the sheath may be thin and transparent so that rice bodies if present may be seen through it.

Instead of herniating quickly through the smallest opening in the deep fascia, the oedematous tissue tends to herniate into the wound only when an incision of some length is made. On incising it this oedematous tissue is found to consist of the thickened tendon sheaths and tendons, more or less closely matted together (Fig. 7). If the process is not far advanced it is possible to separate the individual

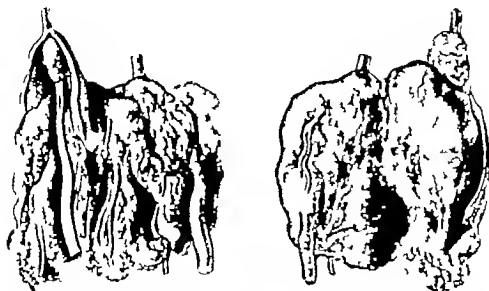


Fig 8 Drawing of tissues operatively removed consisting of the radial and ulnar bursae and frayed invaded flexor tendons to the index and little fingers. The bursae have been converted into thick walled sacs containing many loculi filled with soft, gelatinous, grayish material. The tendons to the index and little fingers within the sac were transformed into a yellow caseous mass.

tendons from one another. Then it may be seen that the involved tendons, with their sheaths, form a fusiform enlargement. The vascular sheath varies in thickness from 0.5 to 3 millimeters depending on the duration of the disease. On incising the sheath the thickened tendon appears within it. Much of the fusiform enlargement disappears as thin, straw colored fluid occasionally with flakes of fibrin pours from the open sheath. The thickened tendon is still free in the sheath, and on incising the tendon, it is found that the thickening is due to involvement of the visceral layer of its sheath. The white fibrous tendon is still intact within the soft vascular granulation tissue which has replaced the normal tissue paper visceral layer of the tendon sheath. During

this stage the tendon can still be dissected out of the tuberculous sheath and shows little or no pathological change. This is the earliest stage of the so-called hygromatous form.

In a later stage the sheath becomes partially obliterated by fibrous tissue formation. Fluid is confined to a definite portion of the sheath, and rice bodies may appear in the fluid.

At times there is found a formless pultaceous or fibrinous material in the sheath of the same color as rice bodies and thought to be an early stage in rice body formation. We are fre-



Fig 9 Tuberculous tenosynovitis of the radial and ulnar bursae. Process in palm has spread beyond anatomical limits of the sheaths involving middle palmar space.

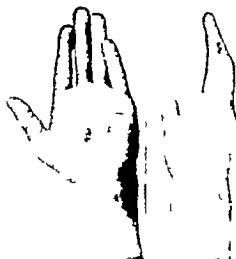


Fig 10 Tuberculous tenosynovitis of the radial and ulnar bursae accompanied by an invasion of the thenar space.

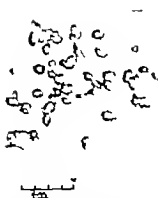


Fig. Rice bodies removed in a case of tuberculous tenosynovitis. The variable size of the rice bodies is shown, the largest one is over 25 millimeters in length, the smallest less than 2 to 3 millimeters.

quently surprised at the scanty amount of fluid if there are numerous rice bodies present.

Still later the fluid is replaced by a caseous substance which may be localized in one or two areas. The tendon sheath is replaced by granulation tissue and later by fibrous tissue, fragmentation of the tendons takes place (Figs. 8 and 28) and several tendons, or all of them, may be firmly bound together in a mass of fibrous tissue.

These varying conditions, described as characteristic of different stages of the disease may at times be seen in the same individual. Straw-colored fluid with rice bodies may be present in the radial and ulnar bursae while the tendons of the fifth finger in the palm have undergone almost complete fragmentation and division. Such fragmentation can occur while the tendon still moves freely in its sheath.

The final stage of the uncomplicated disease, the fungus form, is characterized by extensive formation of granulation tissue and caseation, with or without rice bodies. The exposed tuberculous mass is very vascular, soft and of a grayish-red or purple color. It looks like a mushroom-shaped enlargement which has replaced the tendinous mass. When the soft, thick granulation tissue forming its outer wall is incised, the interior of the tendon sheath with the involved tendon is exposed. There may be some thick gelatinous, straw-colored fluid present there may be rice bodies there may be only caseous material within the synovial space. At times the swelling may be bifollicular with rice bodies present in one loculus and gelatinous fluid in another. The lining membrane of the tendon sheath is no longer glossy and shining, but dull and lusterless. It may be adherent to the tendon in a part of its course. It frequently shows areas of caseation and necrosis.

Occasionally the infected sheath ruptures and one or more of the fascial spaces of the hand and forearm are invaded. The middle

palmar space or the thenar space may be distended and filled with tuberculous tissue (Figs. 9 and 10). However it is somewhat more usual for extension to occur into the forearm. These extensions when they occur in the palm tend to be encapsulated though this is not the case in the forearm.

The visceral layer of the sheath is involved like the parietal layer. The tendons lose their white shiny luster, their surfaces are covered by the same type of tissue as lines the interior of the sheath (Figs. 8 and 28). When this is removed the tendons may appear normal or there may be invasion of the tendon substance by the tuberculous tissue. In the early stages this is evidenced by a separation of the fibers by a small red or reddish-brown mass of tuberculous granulation tissue. Later the tendon appears soft and swollen, greyish-yellow or even caseous and frayed. With this invasion and destruction the tendon soon loses its tensile strength and ruptures. Once the tendon has become invaded the tuberculous process tends to spread for a short distance in a longitudinal direction so that a section made across normal appearing tendon distal or proximal to the area of definite tuberculous invasion may show a central area of destruction (Fig. 14, b).

This process of tendon destruction is most marked in places where the tendon is confined within a narrow space that is, within the carpal tunnel under the transverse carpal ligament. This is probably due to the swelling which interferes with the blood supply of the tendon and makes it more easily invaded by the infection.

In 12 of our 23 patients one or more tendons were either completely destroyed or so badly involved that whole segments required removal and plastic repair was necessary in 10 of these, while in another 5 patients there was considerable fragmentation and invasion but it was possible to excise the affected portions without sacrificing the whole tendon. This is a rather startling figure and again emphasizes the fact that both visceral and parietal sheaths are attacked in the disease. There is a certain correlation between severe tendon involvement and duration of the condition before operation. The duration of symptoms previous to treatment



Fig 12. a, Photomicrograph of rice body ($\times 35$). This is the type made up of amorphous fibrils and coarse granules of fibrin-like substance laid down in a concentrically laminated fashion. b Photomicrograph of cellular type of rice body composed of round or polygonal cells with many large spaces filled with homogeneous material ($\times 35$)

in 12 patients with marked tendon destruction requiring excision of whole segments of tendons averaged 51 months. In 5 patients with marked involvement but not sufficiently severe to necessitate more than excision of superficial layers from the tendon, the duration averaged 33 2 months while in 6 patients with slight or no tendon invasion the average duration was 23 months. This correlation holds in general even though the severity of the process shows marked variation from case to case. Thus although in 2 patients with marked destruction the condition had been present for 10 years the duration in the other patients in this group (ranging from 6 months to 5 years) averaged 31 1 months. In the group with the least involvement there was 1 patient in whom the swelling had been present for 8 years in the 5 remaining patients however the duration ranged from 5 months to 2 years with an average duration of 12 months. We can say therefore that, in general if the disease has been present over a year tendon invasion is sure to be found and that if it has been present for 3 years or longer there will be considerable destruction and that plastic repair will be needed.

The tendons most frequently severely invaded and destroyed are the flexor tendons of the little finger, next are those of the index finger and then those of the middle and ring fingers. The flexor pollicis longus is somewhat more frequently involved than the flexor tendons to the index finger but this involvement is seldom so severe and in our experience has never destroyed this tendon and plastic repair has never been required. On the dorsum of the hand the extensors of the thumb especially the extensor pollicis longus, are frequently fragmented while the common extensors though often fragmented are seldom actually destroyed.

In 9 instances other structures in the hand besides tendon sheaths and tendons were invaded. In only 3 instances were bone and joint changes found and in each case we felt that this was distinctly secondary to the tenosynovitis and not the primary focus. In 1 of these the bones and joints of the index finger were so extensively invaded that amputation of the finger was necessary. In another case there was a focus in the lower end of the radius which was not curetted and which healed completely following excision of the infected

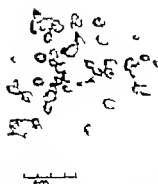


Fig. 11. Rice bodies removed in a case of tuberculous tenosynovitis. The variable size of the rice bodies is shown; the largest one is over 25 millimeters in length, the smallest less than 2 to 3 millimeters.

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The histological picture of a rice body presents chiefly granular and poorly defined eccentrically lamellated masses of coarse granular and thread like fibrous material (Fig. 12) or tissue which has undergone coagulation necrosis which contains here and there a giant cell and occasionally the tubercle bacillus. In some instances the rice bodies are very nuclear composed of round or polygonal cells with many large spaces filled with homogeneous material. Tubercle bacilli may frequently be demonstrated in them. Goldmann and Garré showed that these bacilli are capable of producing tuberculosis in a guinea pig if the rice bodies are implanted in the peritoneal cavity provided a sufficient number are implanted.

MICROSCOPIC PATHOLOGY

The histology of tuberculous tenosynovitis is similar to that of tuberculous of the synovial membrane of the joints. The sheath is thicker than normal (Fig. 13) and in the outer part there is usually a considerable increase in fibrous tissue with increased vascularity. The vessels of this fibrous layer may show perivascular round cell infiltration or a tuberculous endarteritis. Lymphocytes in considerable abundance are frequently found throughout the fibrous layer. Closer in toward the inner surface of the sheath may be found numerous or scanty histological and conglomerate tubercles contained in dense chronically inflamed fibrous tissue. The surface of the sheath is usually converted into vascular granulation tissue which resembles ordinary granulation tissue except for the fact that it frequently contains tubercles. Fibrin deposits may be found on the surface of the synovial membrane or large and small blunt papillae may be given off. These papillae may be cellular and vascular or they may be necrotic.

In the more advanced or in the more rapidly developing cases larger or smaller areas of caseation may occur (Fig. 13) and typical tuberculous ulceration may be present on the surface of the synovial membrane.

Similar changes occur in the visceral portions of the sheath which in advanced cases may be converted into ragged and irregular

necrotic and granular masses adherent to the surface of the tendon. The fibrils are separated by granulations and the tendon may become converted into a mass of conglomerate tubercles (Fig. 14). Once inside the tendon the process may multiply proximally and distally from the site of involvement. Within the outer zone of normal tendon surrounding a central necrotic area.

It is of interest to note that the pathological picture may not always show tubercles so that a diagnosis of tuberculous may not be made by the pathologist unless the source and clinical history of the material is known. The tuberculous infection may produce only a chronic inflammation which could be due to any other infectious agent. In such cases a guinea pig test is necessary to make the diagnosis.

SYMPTOMS AND CLINICAL COURSE

Tuberculous tenosynovitis is characterized by the insidious development of a slowly progressive painless or painful swelling over the anatomical area of the tendon sheath in which is involved. As the disease develops various symptoms occur some due to the extension of the swelling some to pain and some to destruction of tendons. A long neglected secondary involvement of adjacent structures especially bones and joints and fistula with secondary infection occur.

The initial symptoms of tuberculous tenosynovitis are usually pain and swelling or simply swelling over the involved sheath. In fully one third of the cases however sensory or functional symptoms precede the development of the swelling. Thus in our case there was first noted a stiffness in the distal interphalangeal joint of the ring finger followed in several months by similar stiffness in the index and little fingers and not until 5 months later did swelling begin at the wrist. In another case the same peculiar stiffness was first noted in the little finger on awakening in the morning; this was soon followed by stiffness in the other fingers, while swelling did not appear for a year. In a third case stiffness followed an injury and was rather early associated with slight swelling which did not become marked for nearly 3 years.

In another type of case pain or tingling is the first symptom. In one such case a soreness was noted on the volar surface of the distal phalanx of the thumb; this was followed by the development of a small nodule which was picked off and allowed the escape of pus. Following this the thumb became swollen. In 2 cases pain was present for 2 and 3 years, respectively before swelling of any noticeable degree was present. In another case the pain spontaneous as well as on use started in the proximal interphalangeal joint of the middle finger and only sometime later did swelling make its appearance. In still another instance the initial symptom was a numbness, tingling or needle-like pricking sensation in the middle finger. This tingling progressively involved the other fingers and only after some time had elapsed did swelling occur at the wrist. The leathery crepitus which is so typical of traumatic tenosynovitis may occasionally appear at the onset. However we have never noticed it in any of our patients. This leathery crepitus must not be confused with the grating or shot like crepitus which appears late in the disease which is due to the presence of rice bodies.

The swelling may appear as a sudden edema of the hand which very often quickly subsides under rest and heat, only to recur at some later time and to be gradually replaced by the more tense permanent swelling over the anatomical areas of sheaths involved. The swelling most often makes its appearance at the wrist and as it enlarges proceeds distally into the palm, and later into the digital sheaths of the thumb and little fingers. If the digital sheath of the index, middle or ring finger is affected the swelling first appears over the proximal phalanx and later as the cul-de-sac becomes distended progresses proximally into the palm over the metacarpophalangeal joint. In cases of long standing the process extends beyond the border of the sheaths and becomes manifest as globular swellings in the various fascial spaces of the hand or forearm. The thenar space and the subfascial spaces over the thenar area may be distended so that a picture resembling thenar space abscess is produced (Fig. 10). In the same manner the middle palmar space

may be invaded and a tense globular swelling may project from the palm of the hand (Fig. 9). More often the fascial spaces in the forearm are invaded thus producing swelling above the wrist well beyond the outlines of the proximal ends of the radial or ulnar bursa.

The pain in tuberculous tenosynovitis while present to some degree in all but a few patients is seldom severe. When it is severe it is described as a burning or throbbing ache often radiating upward over the forearm, made worse on use of the hand. In such cases the pain is worse at night and the patient is often awakened by it at two or three o'clock in the morning. The pain may respond at these times to the application of heat or cold. For some reason or other the pain does not tend to persist as a prominent symptom throughout the course of the disease. It may become more and more severe during a period of 1 to 2 years and then subside or even entirely disappear. The fact that a similar subsidence of pain may follow incomplete operations or even aspiration suggests that this peculiarity is due to tension within the bursa which is relieved either by rupture of the bursa or by mechanical drainage.

Another characteristic of the sensory disturbance is its frequent reference either as actual pain or as burning, tingling or numbness over the peripheral distribution of the median and less often ulnar nerves. Such reference is to be explained by the almost constant involvement of the median nerve and less frequent of the ulnar nerve in the pathological process. The radiating pains may pass down into the fingers, or upward over the forearm to the elbow. These also may gradually subside as the disease progresses, a fact which is somewhat difficult to explain when at operation we find the nerve swollen and engorged.

As the disease progresses various functional disturbances make their appearance. These may vary from slight or no disability in the early case to actual loss of various movements due to tendon destruction or to the interference with motion by the actual size of the swelling which may prevent complete closure of the fingers, adduction of the thumb or flexion and extension of the wrist. Pain on

motion may lead to limitation of use. In a few instances the patient recognizes the actual time at which a tendon has divided and may remark that he felt something snap and that afterward a certain movement was absent. A complaint which patients frequently make is the inability to make a fist or completely close or extend the fingers. This may be the earliest functional disturbance and one which frequently persists for months after removal of the infected sheath.

EXAMINATION

Examination of the hand shows a swelling or enlargement over the course of the involved sheaths (Figs. 1, 2, 3, 4, 5). In the case of the volar sheaths there is frequently a fusiform or spindle shaped swelling of the wrist which is divided into two fairly distinct portions, a proximal and a distal by the transverse carpal ligament. This constriction may be visible and is practically always palpable. The communication of the two loculi can be made out by pressure on one and palpation of the other when the tension will be found to increase as pressure is exerted. The palmar swelling may be more marked than that in the forearm (Fig. 9) and may occupy the center of the palm and show no demonstrable connection with the forearm enlargement. Such a tumor mass, often cystic in its consistency, may indicate middle palmar space invasion. The swelling may appear perfectly regular and smooth in outline, or it may appear irregular and lobulated as if made up of a number of separate masses or of one mass of varying consistency and composition.

The swelling in the base of the palm is indicative of ulnar bursa infection; may be directly continuous with swelling of the fifth finger (Fig. 4) or as is not infrequently the case there may be no external evidence of involvement of the digital sheath, even though it is found invaded at subsequent operation. Similarly the thumb may be markedly swollen along its volar surface with disease of the radial bursa (Fig. 5).

With tuberculosis of the sheaths of the index, middle and ring fingers there is produced a sausage shaped or fusiform enlargement which may lead to confusion with apina-

ventosa (Fig. 2). However examination will show the definite localization of the involvement to the volar surface of the finger and the prolongation into the palm to the limits of the sheath.

The dorsal swellings tend to be more irregular and to be made up of several distinct tumors which correspond to the numerous separate sheaths which may be involved here (Fig. 3). Thus several tumors may be felt as elongated masses which cause as in the case of volar disease, a fusiform swelling of the wrist with a poorly marked constriction at the center. The swellings on the dorsum may produce localized globular masses, often attaining the size of a hen's egg or lemon (Fig. 15). The distal limit of the masses corresponds to the limits of the dorsal sheaths, i. e. about the middle of the metacarpus, while they extend proximally 1 to 2 inches above the dorsal carpal ligament.

The swellings may vary considerably in consistency. Some are hard, firm, and tense; others are soft, boggy, and doughy while still others are fluctuant or semifluctuant. The consistency may vary considerably within the same tumor, some areas may be quite hard, others soft or fluctuant or even cystic.

Crepitus or grating is nearly always demonstrable when the rice bodies are present. They give the sensation of shot being moved back and forth in a closed sac. The patient will usually have noted this himself. In the very early stages the leathery crepitus of tenosynovitis may be noted but this is rarely found by the surgeon.

Usually the skin is uninvolved; it may be slightly reddened or if considerable tension, particularly with middle palmar space invasion it may be white and tense. There is no increase in local heat and no tendency for the skin to become attached to the underlying mass. In the later stages of the disease with cold abscess formation, fistula and secondary infection lead to the typical changes (Fig. 23).

Tenderness is not a marked characteristic though in a few instances we have noted some and in one considerable tenderness. While motion of the wrist may cause pain, pressure applied over the mass does not necessarily do so.

PROGNOSIS

No case should be allowed to progress to the stage at which severe secondary infection jeopardizes the patient's life. In a certain number of cases recurrence will take place despite careful operative excision of the diseased sheaths. Some will require several operations either because of incomplete removal or because of involvement of tissue which at the initial procedure does not seem to be diseased.

Of the 23 cases of histologically proved tuberculous tenosynovitis treated by us 2 have succumbed to tuberculosis. One died of laryngeal tuberculosis 12 years after the initial operation or 14 years after the onset of the tenosynovitis. The other patient had an active pulmonary tuberculosis at the time of operation (under local anesthesia) went to Colorado immediately afterward for treatment and succumbed some 6 years after operation and 6½ years after the development of the tenosynovitis. (A third patient succumbed to a heart attack 2 months after operation.) So far as we have been able to ascertain the two patients mentioned have been the only ones who have died from tuberculosis.

Most of the patients had had some attempts at treatment before we saw them. This consisted in most cases of the application of a plaster cast or some other type of immobilizing apparatus for a variable period of time usually on an empiric basis since in very few instances had the correct diagnosis been made. In a few instances hot dressings were applied to control pain in some various salves and ointments were prescribed for local use and in others ultraviolet therapy was instituted. In none of these cases was there anything more than temporary alleviation from symptoms and in this connection the following history is of considerable interest.

Mrs. M. B. (P. M. H. No. 12249) entered Passavant Memorial Hospital, November 16, 1932, complaining of stiffness and soreness of the right hand, difficulty in closing the fingers of the hand, swelling above the wrist and in the palm, and a grating sensation upon movement of the fingers. The trouble dated back to February, 1928, about 5 years previously and was thought by the patient to have followed a slight trauma sustained on the dorsum of the hand while she was cleaning a wash-bowl. The

injury was not especially painful but, on the day following, the index and little fingers became stiff and swollen. She consulted a physician who gave her a hand vibratory treatment and asked her to return in 3 days, at which time there was swelling over the knuckles and in the distal portion of the palm. She continued treatments for some 6 months during which time the hand grew steadily worse. Infra-red light, ultraviolet light, X-ray, diathermy, and vibration were all tried and finally the hand was immobilized by bandaging, after which it became very stiff. By the end of the 6 months the swelling had extended into the base of the palm where the patient said she thought she could feel liquid. For the next 6 months she took osteopathic treatments, which she felt made the condition worse, so she consulted another physician who made a diagnosis of traumatic neuritis and later changed it to arthritis. She was given autohemotherapy twice a week for a considerable period of time, with no results. She then took a course of treatments with another osteopath, and gave up after 4 months with no improvement. Another physician was seen who painted the arm and hand with tincture of iodine and wrapped it with copper wire. This was left on for 6 weeks with no change in the swelling. During the next 2 years she consulted numerous other doctors and osteopaths. X-ray pictures were made and all sorts of treatments attempted. Sometime in the spring of 1931 a grating was felt on flexion of the index and little fingers. Just how this was interpreted we do not know, possibly as a Charcot joint, for about this time she was told the trouble was of nervous nature and was advised to consult a nerve specialist about it. Another physician at this time told her the wrist was fractured and would require fracturing over and resetting. Nothing further was done until the spring of 1932 when the patient in desperation took a course of Vitonoid treatments. These consisted of wrapping a rubber tire about the body five times daily and placing the hand on the tire. She kept this up for 3 weeks without result. In October, 1932, she consulted a doctor who gave her a complete examination and made an X-ray examination of the chest. This physician thought the trouble was tuberculous and suggested operative treatment. After further consultation an operation was decided upon. At operation an advanced tuberculous tenosynovitis of the radial and ulnar bursae and the digital sheath of the index finger was found, with many rice bodies, some very large (Fig. 11) and with considerable fragmentation, though not complete destruction of tendons.

In 3 patients the swelling was aspirated elsewhere one or more times, with some relief from the pain but almost immediate recurrence of the swelling. In one case the aspiration treatment was followed by sinus formation and the discharge of rice bodies from the wound (Fig. 16).

In 7 patients operation had been performed previous to the time we saw them. In 5 of these patients the procedure was fairly extensive and was repeated once in 1 patient and twice in another. In the 2 other patients very minor procedures were attempted in 1 merely incision, in the other a small bit of tissue was excised.

Of the 23 cases 6 required two or more extensive operations before the process could be eradicated.

1 In 1 case a thorough excision of the radial and ulnar bursa was followed in 6 years by a tuberculous tenosynovitis of the digital sheath of the index finger. This was excised but recurred again in 4 months with such bone involvement that amputation of the finger was thought advisable. It is doubtful if this sheath was involved at the time of the initial operation.

2 In another case (Rutt) a thorough excision of the radial and ulnar bursa was followed in 3 months by infection in the digital sheath of the ring finger. This sheath was excised and 2 years later there was no recurrence. In this case the digital sheath was probably already infected at time of the first operation but was not recognized.

3 J M (W 110195 P M H 880) was operated upon for a tenosynovitis of the right middle finger. This recurred some 5 years later and a second excision was performed.

4 P (W 119134, 121115) was operated upon for an extensive tuberculous tenosynovitis of the radial and ulnar bursa. Four months after the operation he returned with a similar process on the dorsum of the same hand which was also removed. Ten months later a cold abscess over the head of the ulna was opened and curetted.

5 M (W M H 134039 137599 P M H 708. Figs. 30 and 31) presents an interesting history in that three attempts were made to treat the patient operatively previous to our operations and we were required to perform three further operations before the process was completely eradicated. In the first of our operations the common extensor sheaths were excised. Six months later a recurrent infection about the extensors of the thumb was found and removed. Eighteen months after the second operation there was another recurrence about the extensors of the thumb with complete destruction of both the long and short extensors. The long extensor was replaced by a tendon graft. There has been no recurrence of the process 4 years after this last operation.

6 W (W M H 14-434 144308) In this patient an extensive tuberculosis of the radial and ulnar bursa and of the common digital sheath of the index finger was excised (Fig. 1). Four months later she returned with a recurrence above the wrist. This was found to have invaded the muscles of the forearm.

Recurrences have occurred in 5 other instances but re-operation was not performed in any. In 1 case an advancing pulmonary infection made operative interference inadvisable. In another a sinus with secondary infection developed. This was treated conservatively with plaster cast and sunlight for 9 months. The process subsided and a re-examination 12 years after operation showed a perfectly functioning hand (Fig. 17). In 3 other cases, recurrences have taken place 3 months, 20 months and 16 months respectively after extensive operation. These patients have been advised to have another operative excision.

That lasting cure may be obtained over a long period of years by proper treatment is attested by a number of our cases of which those illustrated in Figures 16, 17, 18, 19 and 20 are examples.

Of the 23 cases postoperative information is entirely lacking on 5. Of the 18 remaining 13 or over 72 per cent, have remained free of recurrence for periods varying from 2 months to 12 years after operation.

M W M H. 80905—2 months S W M H. 113373—3 months G W M H. 130029—1 year, 7 months R. W M H. 91841 and 91533—2 years T P M H. 6777—2 years, 4 months S P M H. 6108—2 years 6 months P P M H. 5781—2 years 7 months M W M H. 134939, 137599 and P M H. 708—3 years O W M H. 40677 86102 88771—6 years G W M H. 124880—7 years C W M H. 86002 7 years, 3 months M W M H. 117167—7 years 10 months S W M H. 91649—12 years

Of the 5 remaining cases 2 patients have died, one 6 years after operation of pulmonary tuberculosis and with recurrence of the tenosynovitis, the other 2 months after operation of acute cardiac failure. The 3 others have recurrences for which further operative treatment has been advised.

DIAGNOSIS

The differential diagnosis is usually not difficult. *Gonorrhoea* may rarely be confused. This, however, is always metastatic, is preceded by the primary infection (usually urethral) by some 3 weeks to 3 months and the onset is likely to be more acute though it may rarely resemble tuberculosis. The extensor sheaths are more likely to be involved than

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On the dorsum of the right hand there was seen a flattened egg-sized mass which extended from the dorsal carpal ligament distally to about the middle of the metacarpus and laterally from the second to the fourth metacarpal bones (Fig. 21). In the middle dorsal area of the forearm just above the dorsal carpal ligament was a soft, fluctuant area about 2 centimeters in diameter and raised about one half centimeter above the skin level. These swellings had remained the same since onset.

At operation January 2, 1930 under local anesthesia a middle dorsal incision was made from one-half inch above the metacarpophalangeal joints to 2.5 inches above the wrist exposing the tumor under the subcutaneous tissues and the dorsal carpal ligament. On opening the tumor yellowish, gelatinous fluid poured out, and within the tumor in its most prominent portion was a free, flat, hyaline like mass likened to the early stage of rice body formation. The tendons of the extensor digitorum communis ran through the tumor surrounded by the gelatinous tissue and a reddish purple granulation tissue. The extensor indicis proprius was involved the extensors of the thumb and the extensors of the wrist were apparently not involved. The tumor and granulation tissue were carefully excised. The dorsal carpal ligament was also excised where it overlay the tumor mass. A narrow band of ligament was reconstructed with the aid of healthy looking tissue at the radial side. None of the tendons were frayed or fragmented though the diseased tissue was intimately attached in places to the substance of the tendons. The pathological report on the tissue removed stated: "the lining of the tendon sheath is composed of granulation tissue. Some of the material is composed of fused fibrin and necrotic material with areas of infiltration with polymorphonuclear leucocytes and of fibroblasts indicating beginning organization. There is no evidence of tuberculosis. Diagnosis acute and chronic inflammation."

The postoperative course was uneventful and the wound healed by first intention. A letter November 17, 1932 (nearly 3 years later) stated that the hand was in perfect condition.

S. S. P. M. H. 2647 (May 9, 1930-May 15, 1930). A student of 17 years entered the hospital because of a painful swelling over the right wrist and distal end of the radius. The onset dated back 3 years when she noticed a small swelling of the right wrist over the extensor tendon of the middle finger. The swelling was painless at the onset and gradually increased in size. About 6 months after the onset she noticed that when she held her hand in one position for a long time, pain was felt in the swelling which by this time had attained the size of a half marble. Shortly after this the swelling began to cause her considerable discomfort and she consulted a surgeon who removed it. Soon after this operation the swelling recurred and has continued to increase in size until the time of admission. Six months before admission the tumor again became persistently painful. There was no history of respiratory disease nor

were there any pulmonary or other findings suggestive of tuberculosis.

At examination there was found on the dorsum of the right hand, just distal to the carpus and over the extensor tendon of the middle finger a soft, fluctuant half marble sized non tender mass (Fig. 22 a, b, c). Just proximal to the wrist and in a direct line with the distal mass was a second, soft, fluctuant, but more diffuse swelling.

Operation May 10, 1930 revealed what appeared to be tuberculous granulation tissue surrounding the extensor tendons, some thick straw-colored encysted fluid in some of the sheaths, one rice body and a slight beginning fragmentation. The granulomatous and scar tissues were carefully excised from around the tendons. The dorsal carpal ligament was sutured and the wound closed without drainage. The pathological report on this tissue stated that the inner surface of the tendon sheath was thrown into numerous villous processes containing areas of myxomatous degeneration and of infiltration with lymphocytes and plasma cells. No tubercles were seen and the diagnosis was a simple chronic tenosynovitis.

The operative wound healed nicely and the patient was discharged with the hand in a cock up splint to return for physiotherapy. The patient was again seen December 5, 1932 about 31 months following operation. She stated that she had perfect function of the hand could play the piano and that all movements were normal except for a slight tendency to extension of the index finger when she made a fist. There was no evidence on examination of any recurrence of the trouble (Fig. 22 d, e, f).

L. K. P. M. H. 9673 (March 6, 1932-March 13, 1932). A woman, aged 43, entered the hospital with the history that about 4 1/2 years previously she had noted a swelling over the palmar surface of the proximal phalanx of the right ring finger. There were no signs of inflammation in the mass which slowly but progressively enlarged until it extended over the metacarpophalangeal joint into the palm. About a year later she consulted a physician who excised the portion of the swelling overlying the metacarpophalangeal joint and informed her that a cyst had been found. Since the operation the swelling has gradually increased until it covered the middle and proximal phalanges and the metacarpophalangeal joint. Although there has been progressive loss of function of the finger there was no pain until 6 weeks previous to hospital admission when an aching pain developed over the medial side of the forearm and elbow. There was no history of any pulmonary disease in the family and examination revealed none in the patient.

Examination of the hand (Fig. 23 a, b, c) showed a marked swelling of the middle and proximal phalanges of the ring finger which gave the appearance of a spina ventosa. There was seen a 2 inch scar over the metacarpophalangeal joint and fluctuation could be detected on palpation over this area. There was marked disability of the finger in that there was but so degrees of flexion in the metacarpophalangeal

joint 30 degrees in the proximal interphalangeal joint which could be extended to 120 degrees, and no active flexion in the distal interphalangeal joint which was held in complete extension.

On March 7 1933 under ethylene anesthesia the old operative scar was excised and the incision enlarged so as to extend from the distal flexion crease of the finger proximally into the palm to the transverse carpal ligament. Beneath the skin was a soft, bluish mass which looked like tortuous veins, but, upon cutting into it, it was found to be made up of soft grayish granular tissue which involved the flexor tendons from the insertion upward to the wrist. This material also surrounded the tendons of the fifth finger and this sheath was therefore exposed in the finger and in the palm. The granulations were very difficult to remove from the tendons of the ring finger and it was necessary to excise the sublimis tendon. The little finger tendons were more easily freed. After all diseased tissue had been removed bits of tendon were sewed over the proximal phalanges of the ring and little fingers to serve as transverse digital ligaments and the incision closed.

Microscopic examination of the excised tissue showed it to be made up of yellow lobulated masses of typical granulation tissue. No tubercles were seen.

Healing occurred promptly and the patient was discharged to return for dressings.

The patient returned April 9, 1933 because of extension of the process into the palm and wrist. She had noted a gradually increasing tumefaction just over and above the wrist which in the past 4 months had become more painful. There was no recurrence of the process in the ring and little fingers, though these fingers were still quite stiff especially in the interphalangeal joints (Fig. 35).

At operation (May 10, 1930, ethylene anesthesia) a watery seropurulent fluid was found in the sheaths in the forearm and the sheaths themselves seemed more gelatinous and less fibrous than normal. The tendons of the little finger were intact but were bound down by fibrous adhesions, as were also the flexor tendons of the index and middle fingers though less so. The flexor pollicis longus was intact and its sheath was not involved. All of the diseased tissue was excised. The patient made an uneventful recovery and was discharged from the hospital on the fifth day.

Microscopic sections showed dense, fibrous, rather highly vascular tissue with an abscess in one place surrounded by granulation tissue. There were no tubercles. A guinea-pig inoculation test made from the synovial exudate was negative for tuberculous.

The 6 cases of which the 3 just summarized are good examples presented all the clinical characteristics of tuberculosis with the exception that in no case was there a history of trauma. Four of the patients were females (17, 41, 43 and 43 years of age, respectively)

and 2 were males (50, 52 years of age). 4 had involvement of right hand and 2 of left. In 3 the volar sheaths and in 3 the dorsal sheaths. In 2 patients the condition was very early (both dorsal) and involved the sheath of the common extensors of the fingers and there was no extension into the sheath of the thumb tendons. In 3 cases the tendons were badly involved, so much in one instance that it was necessary to replace the flexor digitorum profundus to the middle finger with a tendon graft (Figs. 35, 36). In 5 cases rice bodies were present, once in very large numbers, in the others very few. In 1 case (Figs. 24, 25) as a large conglomerate mass measuring 8 by 20 by 40 millimeters. Pain was a prominent symptom in 2 instances and was the immediate reason for seeking operation while in only 1 case was pain absent. In 1 case there was a recurrence and a second operation was necessary.

These cases are especially difficult to evaluate correctly. Even in proved instances of tuberculous tenosynovitis the histological picture may not be conclusive unless many sections are made and the correct areas chosen for examination. The guinea pig test may even occasionally be negative in instances later proved to be tuberculous by histological section. Since the non-specific group do not present any clinical or gross pathological features which distinguish it from tuberculosis we are inclined to believe a good proportion are in reality tuberculous, while the others belong to the same group of chronic inflammations as does the chronic bursitis.

TREATMENT

Tuberculosis of the tendon sheaths, if unaccompanied by active lesions elsewhere, is probably one of the least difficult of tuberculous processes in which to obtain complete cure. This may be secured either by conservative treatment such as removal of the mason seeds, injection of iodolform emulsion, and immobilization by splinting for a considerable period, or by complete surgical removal. The former method requires considerable time for its application, with consequent loss of use of the hand. As a result of prolonged immobilization, atrophy and contractures of the muscles take place, fibrous adhesions form about the joints, and these conditions are accentuated by the temporary loss of nerve function and by the involvement of the nerves in the pathological process itself. These results, how-



Fig. 14. a Cross section of tendon removed because of tuberculous infiltration. The sheath is obliterated and much of the tendon has been replaced by numerous confluent tubercles. b Longitudinal section through a tendon showing central invasion by the tuberculous process.

ever are usually transitory, and function is restored some weeks or months after removal of the splints. It may be advisable to combine active surgical intervention and immobilization in advanced cases, if the bones and joints are involved in the process.¹

In Dr. Kanavel's paper there are reports of 3 patients treated by the conservative methods. Experience however early led him to abandon these procedures for radical excision and in all the cases herewith reported surgery has been the method of treatment. In early stages or in those patients in whom the diagnosis may not be certain conservative therapy may be tried, however in view of the tendon invasion which may occur it is not advisable to persist long with conservative measures unless improvement is apparent.

We have had no experience with roentgen therapy in this condition. Good results have been reported by a number of capable men notable among whom are Wetterer (1920), Moll (1920), Iselin (1920), and Juengling (1922). The treatment however extends over a con-

siderable period of time and we do not feel the results are as good as those obtained by adequate operative removal of the diseased sheaths.

SURGICAL TREATMENT

The operation may be performed under local or general anesthesia. Although in the earlier cases local anesthesia was used almost exclusively we have come more and more to the use of general anesthesia. This has been done mainly for two reasons, the operation is long and tedious and outlasts both the duration of the anesthetic and the endurance of the patient and secondly because the blood pressure apparatus which we use to maintain hemostasis becomes almost unbearable after 40 to 50 minutes.

A bloodless field is secured by maintaining constriction with a blood pressure apparatus at about 220 to 230 millimeters of mercury. This pressure we have found can be maintained for as long as 90 minutes (in rare instances 2½ hours) without producing nerve injury. At the end of 90 minutes it is well to



Fig. 15. Tuberculous tenosynovitis of dorsum of wrist, its globoid shape and tense consistency might easily lead to its being mistaken for ganglion.

release the pressure and care for all bleeding points, after which the cuff may be inflated again and the operation completed. It is wise at the close of the operation to let the pressure down, ligate bleeding points and re-inflate the cuff before closure of the wound. A snug pressure dressing with a large amount of stuffed up gauze should be applied before the pressure is finally released. In this way we insure a dry operative field and prevent postoperative oozing.

In the earlier cases the dissection was supplemented by splint immobilization for varying lengths of time. This period has been gradually shortened until now immobilization is not considered necessary except in those patients who may be suffering from a complication of the disease such as bone or joint involvement or in whom tendon grafting or suture has been performed.

The incisions should be planned so as to avoid midline scars over the volar surfaces of the digits and to avoid transverse division of skin creases. It is wise also to plan the incision as much as possible in such a way as to raise flaps of skin which upon being replaced fall back over the denuded tendons with the line of skin closure lying to one side.

Adequate exposure of the radial and ulnar bursa with their digital prolongations into the thumb and little finger respectively requires two or three incisions. The main incision is a long one made in the palm, wrist, and forearm and exposes the whole of the ulnar bursa in the palm and above the wrist and the radial

bursa above the wrist (Fig. 26 a). This incision begins distally at the distal palmar crease and passes proximalward along the radial side of the hypothenar eminence to the midline of the wrist. At the wrist the incision curves ulnarward so as to cross the wrist transversely in the proximal skin crease and then passes up the forearm for about 3 inches curving gently toward the midline. The digital sheath of the fifth finger may then be exposed by an incision on the ulnar side of the finger which passes proximalward to the region of the metacarpophalangeal joint and then turns radialward for a short distance into the palm along the distal flexion crease. The sheath of the flexor longus pollicis is exposed by a third incision along the radial side of the thenar eminence and thumb. In the proximal end of this incision great care must be taken to avoid injury to the motor branch of the median nerve to the thenar muscles. The forearm and palmar incision may be varied (Fig. 26 b) by uncovering the radial bursa with one long incision starting on the ulnar side of the distal phalanx of the thumb along the ulnar border of the thenar eminence and then transversely across the wrist and longitudinally upward on the forearm. This incision is particularly of value in instances in which the radial bursa presents the most marked involvement. However in any case it is essential to expose the entire extent of both major bursae even if inspection at the wrist does not indicate the involvement of the digital prolongation of either bursa.

The incisions are carried down through the deep fascia and transverse carpal ligament where the involved sheaths will be found to bulge into the field (Fig. 27). The median nerve, swollen and compressed on top of the ulnar bursa is carefully isolated, wrapped in sponges saturated in normal salt solution and carefully retracted before the diseased tissue is touched. The superficial palmar arch lies across the surface of the bursa and it may be ligated and divided in order to obtain good exposure.

After a good exposure has been obtained the diseased tissue is excised first from the tendons and then from the attachments to the surrounding tissues. The sheath is opened

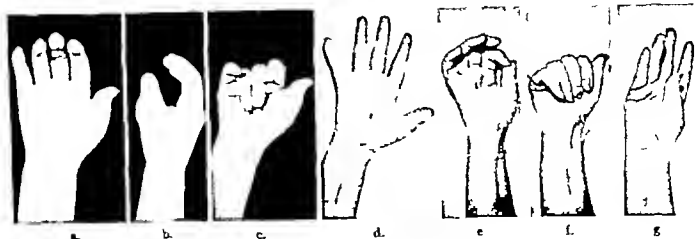
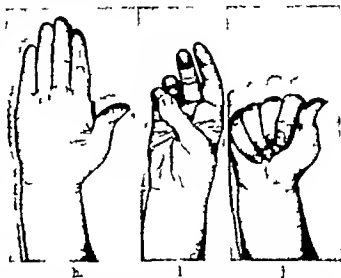


Fig 16 Tuberculous tenosynovitis of radial and ulnar bursae with sinus formation following aspiration. a, b, c. The condition of the hand before operation. At operation the entire extent of both radial and ulnar bursae was found to be invaded, with destruction of parts of the sublimis tendon of the little finger and invasion of the adductor pollicis and first lumbrical muscle. d, e f g. The hand 5 months after operation. There is still some drainage from the sinus on the thumb. The sinus continued to drain for 7 months after operation and then ceased. h, i, j. Hand 9 years 7 months after operation, sinus closed for 2 years, swelling subsided, patient has good functional use of hand.

longitudinally and each tendon lifted up in turn and the visceral layer of the sheath dissected free from it (Fig 28). This will leave the parietal layers of the sheath and the mesotenon and thereto attached visceral sheaths fastened only to the fascia and muscles beneath. After all the tendons have been freed of diseased tissue the infected sheaths may be removed as one or two large masses. In excising this mass from the surrounding tissues it may be necessary to remove bits of deep fascia and muscles in order to remove all tuberculous tissue. When the dissection is completed the median nerve and the flexor tendons lie bare within the forearm, carpal tunnel and palm. While within the forearm and palm there is a moderate amount of fatty subcutaneous tissue over the tendons within the carpal tunnel the tendons are surrounded over fully three fourths of their circumference by bony and dense fibrous walls. These tendons however develop new sheaths within which they glide easily, a fact attested both by functional results obtained and by observation in cases requiring second operations. In such cases the tendons which have remained free of recurrence, are surrounded by gray fibrous tissue through which they glide easily



The tendons themselves frequently show invasion and it is necessary to excise the diseased portions (Fig 29). If the invasion is not too extensive it may be possible to remove the infiltrated portions without damaging the tendon to any extent. However, in many instances tendons will be completely eroded or so badly fragmented as to require surgical removal. In such cases some sort of plastic repair is necessary.

In 10 cases such plastic repair was required. In 6 of these cases (with involvement of 10 tendons) the proximal and distal stumps of the destroyed tendons were sutured under slight tension to adjacent tendons (Fig 29). In 1 case an end-to-end suture of the stumps of the extensor pollicis longus was made after excision of the involved tissue (Fig 17). In 3 cases however, such side-to-side suture was not possible and it was necessary to graft tendons into the defect. A tendon graft was used also in a fourth case of chronic non

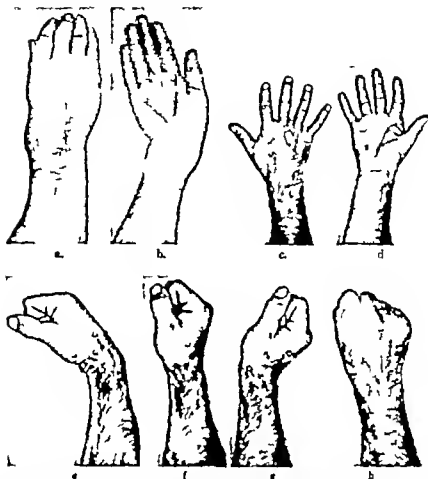


Fig. 17. Tuberculous tenosynovitis of the dorsum of the hand, especially marked on radial side. Involvement of extensor digitorum communis sheath, and sheaths of both extensors and long abductor of thumb. The long extensor tendon of thumb had separated and was sutured. At time of operation there was a focus of tuberculous in the radius which was not touched. Following operation a sinus developed which was treated by amputation and sunlight. Healing occurred in 9 months. a, b (Karnel, *Surg. Gynec. & Obst.* 1933, xlviii, 635) The hand before operation in September 1931. c, d, e, f, g, h, The hand in October 1933. There has been no recurrence in the 18 years since operation.

tuberculous tenosynovitis. The results in all four instances have been satisfactory and since so far as we can determine they are the only recorded instances in which tendon grafts have been used in tuberculous tenosynovitis, we shall report here the history of these cases.

B. M., W. M. H. 134930, 137509 P. M. H. 708. A mechanic, 26 years of age, entered the hospital (October 28, 1917) because of trouble with his right wrist of 18 months duration. The onset of this trouble dated back to June of 1915 when he sprained his wrist while turning a hand wheel at work. At

most at once following this injury a hard tense walnut-sized lump developed on the dorsum of the wrist. The skin over the mass was normal and movements of the wrist were well performed, but were associated with slight pain and weakness. The swelling at this time was diagnosed as a carpal ganglion. Six months later (December, 1915) the patient was operated upon, and 5 or 6 rice bodies were found. The operative wound healed and the patient returned to work with the hand and wrist immobilized on a splint. The swelling gradually recurred and was associated with more severe pain which at times became so marked that he would be awakened from a sound sleep. At this time the weakness of the wrist was more marked though the finger movements were



Fig. 18. Tuberculous tenosynovitis of 18 months duration with invasion of radial and ulnar bursa with extension into the digital sheaths. One month before operation the patient felt the tendons to the index finger snap, since which time she was unable to flex the interphalangeal joints of this finger. The tuberculous tissue was completely excised and the distal stumps of the index finger tendons were sutured to the corresponding tendons of the middle finger a, b. Before operation. c, d. Two and one-half years after operation. (Letter seven years after operation states the hand gave her no trouble and there had been no recurrence.) (Illustrated in Kanavel's original paper *Surg. Gynec. & Obst.*, 1923, xxxvii, 635)

normal. In the spring of 1926 a second operation was performed at which time a sac like structure containing a little fluid but no rice bodies was removed. Shortly after this operation the swelling again recurred and in the fall of 1926 a third operation was performed and so extensive dissection carried out multiple sac like structures being removed. The operative wound healed after being kept open by packing for a period of 6 weeks. In the mid summer of 1927 the pain and swelling again recurred. Up to this time he could still use his hand at work but there was considerable weakness on supination and pronation. The pain was by this time quite severe and awakened him at 3 or 4 a. m.



Fig. 20. Functional result 15 months after operation for tuberculous tenosynovitis of radial and ulnar bursa of 1 year's duration. There was no tendon destruction. The operation was performed in May 1926 these photographs were made in August, 1927. There had been no recurrence in October 1933 7 years and 5 months after operation.



Fig. 19. Tuberculous tenosynovitis of entire radial bursa and of ulnar bursa without invasion of digital sheath in little finger. Destruction of sublimis tendons to ring and little fingers. The tuberculous tissue was excised and the stumps of the sublimis tendon to the ring finger were sutured proximally and distally to the corresponding tendons of the middle finger. The stumps of the sublimis tendon of the little finger were sutured to the profundus tendon of same finger a, Before operation. b, c, Two and one-half years after operation. A communication 7 years and 10 months after operation states there has been no recurrence and that there has been no change since the last photographs were taken.

On admission an egg sized, irregular tense swelling apparently connected with the extensor tendons presented itself on the dorsum of the right wrist (Fig. 30 a and b). An irregular red, shiny scar marked the site of the last operation. The main area of tumefaction extended about 1.5 inches up into the forearm from the annular ligament and distally to about the middle of the metacarpals. The tumor appeared to be made up of a number of globular and elongated swellings. Along the extensor tendons of the thumb there could be seen and palpated as

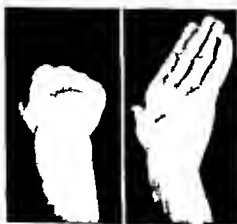


Fig. 21. Chronic non-specific tenosynovitis of the dorsum of the hand.

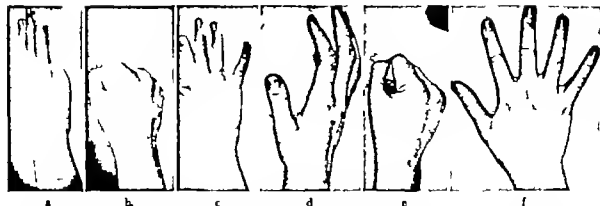


Fig. 22. Recurrent chronic non-specific tenosynovitis of the dorsal tendon sheaths. a, b, c, Before operation. d, e, f, Nineteen months after operation.

elongated mass extending out from the main mass. Active extension was limited to the horizontal while passive extension was limited to about 20 degrees beyond horizontal. Active and passive flexion were limited to about 45 degrees. Movements of the fingers and thumb were not impaired. Palpation of the mass during motion yielded a grating sensation as if there were small shot in the wrist. Examination of the chest did not reveal any lung changes, and no other lesions were found.

Operation (October 20, 1927, local anesthesia) revealed a mass of tuberculous tissue about 7 by 5 centimeters with rice bodies about the extensor tendons. The extensor tendons were taken singly and the tuberculous tissue removed from around each tendon by sharp dissection. A second incision was made over the extensors of the thumb. The pathological report of the tissue removed was "caseous and fibrous tuberculous tissue."

The immediate postoperative course was uneventful and the patient left the hospital with good use of his hand and wrist. After this operation there

remained a small nodule on the dorsum of the wrist. The patient was advised to have this nodule watched carefully and to return if it became troublesome or increased in size. The patient returned to work and was able to use his hand without any difficulty. In the following 5 months the nodule noted above increased slightly in size and on advice of his physician the patient returned for another operation.

At this time (April 9, 1928, local anesthesia) a long incision over the extensor tendons of the thumb showed the extensor pollicis longus and brevis tendons to be surrounded by a soft, in spots yellowish granulation tissue. In one place for about three-fourths of an inch the superficial portion of the tendon of the extensor pollicis brevis appeared to be invaded. All of the granulation tissue and the visceral and parietal layers of the extensor sheaths were removed by clean dissection. The superficial involvement of the extensor pollicis brevis was excised to a depth of about 2 millimeters until normal healthy looking tendon was found. The pathological report on the tissue removed at this operation was

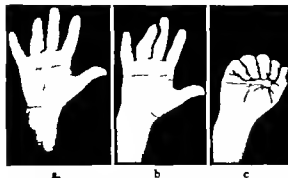


Fig. 23. Chronic non-specific tenosynovitis of the flexor sheaths of the ring and little fingers, recurrent after excision elsewhere. a, b, c, Condition previous to operation. d, e, f, Recurrence in the ulnar bursa at wrist following extensive excision 1 year previously.

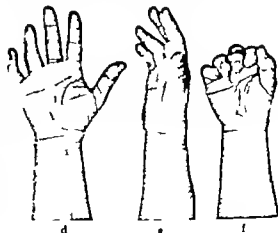




Fig. 24. Chronic tenosynovitis of 3 years duration involving all of the extensor tendon sheaths on the dorsum of right wrist. Marked swelling and almost continuous pain. Tendons quite thin but not destroyed. Photograph shows the condition of the hand before operation. The inset is a photograph of single large rice body 8 by 30 by 40 millimeters. (The white line is 4 centimeters long)

chronically inflamed fibrous tissue containing numerous foreign body giant cells. In places the giant cells were grouped around fragments of foreign material.

The postoperative course was uneventful, the operative wound healed by first intention, and the patient returned to work while continuing post operative ultraviolet therapy.

Following this operation he had perfect use of his hand which was gradually getting stronger and did not cause him any discomfort or trouble for some 16 months, that is, until August of 1939. At this time a firm swelling again appeared along the extensor tendons of the thumb. Extension of the thumb was limited and associated with some pain. Examination showed a firm rope-like swelling along the course of the extensor pollicis longus, which was not tender or red. Flexion of the thumb was possible but extension was imperfect.

In October of 1939 (October 3, 1939, local anesthesia) he was again operated upon and the old skin scar over the extensor pollicis longus removed. The underlying tendon of the extensor pollicis longus was found large, soft, and swollen especially over the distal end of the carpus. It was infiltrated with grayish yellow tissue and had ruptured about mid way between the muscle and the first metacarpophalangeal joint. The portion of the tendon lying between the muscle belly and the metacarpophalangeal joint was excised and was replaced by a tendon graft (Fig. 31). The tendon of the extensor digitorum communis of the third right toe, with all its sheath was excised for about 3 inches and grafted into position between the proximal and distal stumps of the extensor pollicis longus. The muscle belly of the abductor pollicis longus was pulled under the proximal line of suture to serve as gliding tissue and to prevent hindering adhesions. The tendon of the extensor pollicis brevis could not be found. The

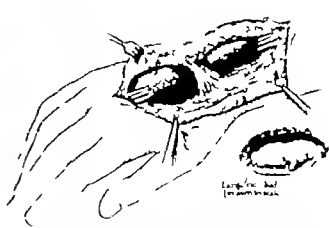


Fig. 25. Drawing made at operation of hand illustrated in Figure 24. The sheath of the common extensors is shown with the constriction produced in it by the dorsal carpal ligament. The radial extensors and the extensors and long abductor of the thumb have not yet been exposed. The large rice body was found lying in the distended sheaths over the metacarpus.

pathological report on the piece of excised tendon stated that for a distance of about 6.5 centimeters in the central part, the tendon was covered by an adherent yellowish gelatinous mass of ragged and irregular tissue (Fig. 14 a). The ends of the tendon appeared normal. A considerable portion of the tendon had been replaced by numerous confluent tubercles. The patient made an uneventful recovery and was discharged after physiotherapy had been begun.

One month after operation, the new tendon was seen to be functioning perfectly (Fig. 30 c d). Examination of the hand 1 year after operation showed no evidence of recurrence (Fig. 30 e f g). The new tendon had healed nicely into position and was functioning perfectly. It could be felt and seen under the skin as a tough, hard movable strand of tissue not unlike a normal tendon. Report from the patient 4 years after the last operation stated that there had been no recurrence and that he was using his hand in his work.

T S P M H 6102. A home girl 31 years of age entered the hospital March 14, 1931, because of a painful swelling of the right wrist and inability to flex the little and index fingers. There was a suspicion of a sprain but no definite history of trauma. At the onset 4 years previously she noted pain and swelling of the volar aspect of the right wrist. After using the wrist the pain became much worse and the swelling larger and more tense. This condition persisted essentially unchanged for 2 years when she noted that she was beginning to lose ability to flex the two distal joints of the index finger. A light cast was applied and the pain and swelling gradually subsided but she began to lose ability to flex the little finger and when the cast was removed she was unable to flex the interphalangeal joints of this finger. At times she thought that she had a slight rise in temperature. Familial history was positive in

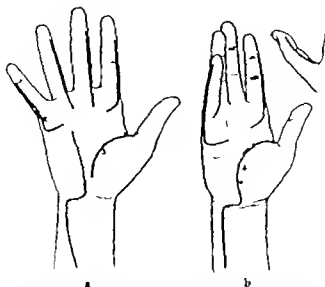


Fig. 16. Diagrams illustrating the types of incisions used to expose the volar tendon sheaths. Adequate exposure of radial and ulnar bursa requires 2 or 3 incisions (see text). In (a) the ulnar bursa proper is exposed by incision 1 and its digital prolongation by incision 2. The radial bursa is exposed by a supplementary incision 3 along the ulnar border of the thenar eminence and thumb. The distal end of this incision is shown in the insert. The proximal end of the incision must stop a thumb's breadth proximal to the transverse carpal ligament to avoid the motor branch of the median nerve to the thenar muscles. The incisions for the digital sheaths are also indicated. If the radial bursa is the most involved (b) the main incision 1 may be made along the thenar eminence and pass transversely across the wrist. The motor nerve to the thenar muscles must be identified and protected.

that her mother had died of tuberculous of the spine. She complained of a chronic cough for the past two winters and stated that the sputum was occasionally tinged with blood. Following removal of the tonsils, however, the cough improved considerably and the blood spotting of the sputum disappeared. Two years previously she had an attack of pain in the right upper quadrant of the abdomen associated with vomiting and jaundice. Since this attack she has been troubled with frequent abdominal discomfort and vomiting. This syndrome was taken to indicate a chronic cholecystitis. General physical examination showed some slight tenderness over the region of the gall bladder. The lungs were clear.

There was a slight, soft, fluctuant, non tender swelling just above the transverse carpal ligament extending across the volar surface at the lower end of the forearm (Fig. 33 a, b, c, d). There was some atrophy of the right arm forearm, and hand. She was unable to flex the index or little fingers at the interphalangeal joints.

At operation (April 15, 1931, ethylene anesthesia) there was found a tuberculous involvement of the sheaths of all flexor tendons from the beginning of

the tendons above to the level of the middle flexion crease in the palm below. The tendons of the index finger were completely eroded. Where the common flexor sheath began distally the flexors of the index finger within the sheath were transformed into a yellow caseous mass (Fig. 8). Just outside the sheath the tendons appeared normal, but in section there could be seen central destruction. The destruction began distally at the middle flexion crease in the palm and extended proximally to the beginning of the muscle. The destruction of the sublimis tendon was a little more extensive than that of the profundus tendon. The tendons of the little finger were destroyed over an area about two-thirds as great as the tendon of the index finger. The tendons of the thumb, middle, and ring fingers were frayed but their continuity was not interrupted. Within the tuberculous synovial sac were many loculi some of them filled with a soft gelatinous material which looked as though it were an early stage in rice body formation, but none of them contained free fluid or rice bodies. The tuberculous tissue including the destroyed and invaded tendons of the index and little fingers were completely excised. The defects in the tendons were repaired by the use of tendon grafts.

(Fig. 33) The distal stumps of the profundus and sublimis tendons of the index finger were sutured together near the base of the finger and the two proximal stumps were united side by side above the wrist. The gap between these stumps was bridged by a graft of palmaris longus tendon. The gap between the stumps of the flexor tendons of the little finger was similarly united by means of tendon taken from the palmaris longus. In this case however only the stumps of the profundus tendon were united. The transverse carpal ligament was sutured, the wound closed, a pressure dressing applied and the hand placed on a flexion splint. Pathological study of the portion of tendons removed revealed a completely necrotic area surrounded by a narrow zone of infiltration with lymphocytes and beginning organization of the necrotic area (Fig. 14 b).

The postoperative course was uneventful and the patient left the hospital with beginning return of active movements.

Examination of the hand on July 3, 1931, about 3 months after operation showed the incision completely healed, and the function of the fingers returning. A second examination in February 1932 showed the further return of function in the fingers. A third examination in October 1933, 2 years and 7 months after operation, showed no recurrence and increasing ability to use the hand (Fig. 32, c, f, g, h).

J. T. P. M. H. 6777. A coal miner of 55 was struck on the palm of his left hand by a falling rock some 15 months previously. The swelling which followed this injury slowly increased and was soon accompanied by pain and considerable disability. Six months previous to admission to the hospital, he was operated upon elsewhere and some of the exuberant tissue excised. Following this operation there was no improvement, a sinus developed and the pain and swelling failed to subside. Upon entrance to the hospital there were found a midline scar on the volar surface of the left wrist and forearm, a draining sinus at the lower end of the incision, and two other sinuses over the thenar eminence. There was moderate non-tender swelling of the wrist, and considerable limitation of flexion of all the fingers. The interphalangeal joints of the little finger could not be actively flexed. At operation there was found to be marked involvement of the ulnar and radial bursae at the wrist and in the palm, with invasion of the interosseous fascia and adductor pollicis muscle. The flexor digitorum sublimis to the index finger and the two flexor tendons to the little finger were found to have been destroyed from the level of the wrist to the distal flexion crease in the palm. The distal stump of the sublimis tendon to the index finger was sutured to the corresponding profundus tendon. The flexor tendons to the little finger were repaired by a transference of palmaris longus tendon in the following manner. The palmaris longus was detached from its insertion and united end-to-end to both distal stumps of the little finger tendons (Fig. 34). The proximal end of the sublimis of the fifth finger was united side-to-side to the palmaris

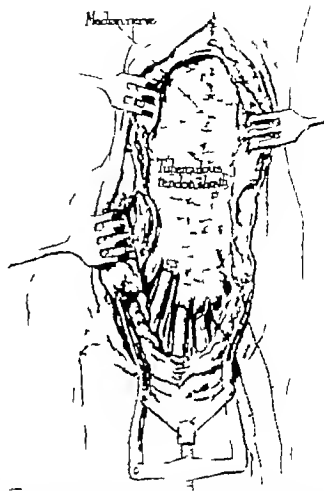


Fig. 37. The incision passes through the skin and fascia and divides the transverse carpal ligament, exposing the distended ulnar bursa upon the surface of which lies the median nerve, which may be entirely surrounded by inflammatory tissue. (From Kanavel, *Surg. Gynec. & Obst.* 1923, xxxvii, 635.)

longus. The postoperative healing was complicated by drainage from the regions of the old sinuses and it took several weeks to secure complete closure. However, at the end of 2 1/4 years the patient reports that the hand is healed though somewhat weak and that he has been back at work.

The last case is not a proved tuberculosis

R. P. P. M. H. 15037. A female of 43 was admitted to Northwestern University Dispensary complaining of pain and swelling on the volar surface of the right wrist and hand of 3 years' duration (Fig. 36 a, b). At operation a marked involvement of the ulnar bursa in the wrist and palm was found, without invasion of the radial bursa in the wrist or thumb or of the digital prolongation of the ulnar bursa. The profundus tendon to the middle finger was so badly invaded that it required excision from the proximal end of the bursa nearly to the heads of the

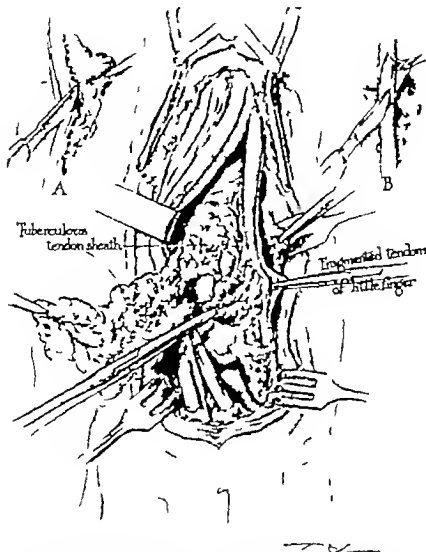


Fig. 8 After the median nerve has been isolated and carefully retracted each tendon is taken in turn and the tuberculous tissue dissected free from it, taking especial care that the vascular sheath, B is entirely removed. (From Kana, *J. Surg. G. & Obst.* 925, xxviii, 635)

metacarpals. The other deep tendons were also frayed in the carpal tunnel, but could be saved. The destroyed segment of the profundus to the middle finger was replaced by a free graft taken from the palmaris longus (Fig. 35). Healing occurred *per primam* and the functional result is satisfactory (Fig. 36 c, d, e, f).

In excising the involved sheaths of the individual fingers incisions are made along either the radial or ulnar border of the finger from the distal interphalangeal joint upward into the palm alongside the metacarpophal-

angeal joint where the proximal cul-de-sac of the sheath is reached (Fig. 26 a and b). If possible we attempt to preserve a bridge of fibrous tissue over the base of the proximal phalanx and over the middle of the middle phalanx to serve as transverse ligaments to prevent herniation of the tendons. This, however is seldom possible since the fibrous sheath is practically always invaded and requires excision. We are accustomed in such cases to fashion transverse digital ligaments

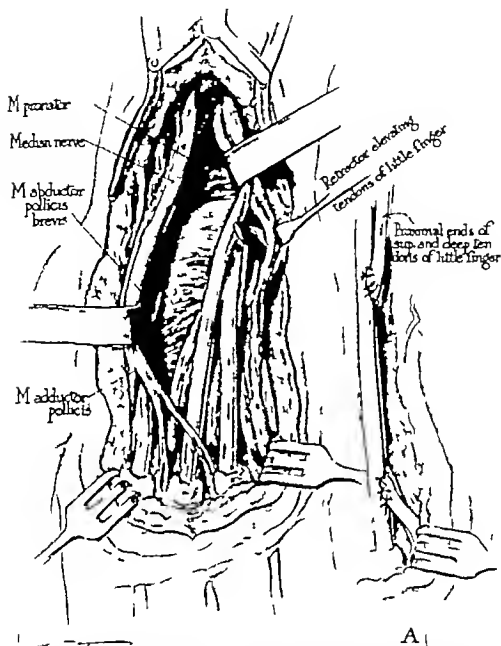


Fig. 29. Every vestige of diseased tissue is removed so that at the completion of the operation the bare tendons lie upon the muscles and fascia of the palm and forearm. It may be necessary to remove badly fragmented tendons. These may be repaired by suturing the stumps to adjacent tendons. (From Kanavel, *Surg. Gynec. & Obst.* 1923, xxvii, 635.)

(Koch) from bits of tendon tissue excised from the palmaris longus tendon or from remnants of attachments of the sublimis tendon. These are sutured to the fibrous tissue along the sides of the bone across the flexor tendons and serve as ligaments to keep these tendons in apposition to the bone. This procedure we have carried out in 5 or 6 cases and have been quite satisfied with it.

At the completion of the operation the blood pressure cuff is deflated and all bleeding points stopped. The pressure is again applied and the incision is closed. Some fine silk sutures are placed in the superficial fascia and the skin closed with fine silk or other fine skin sutures. Great care is taken to obtain as accurate an apposition of the skin edges as possible. Small rubber strips may be inserted in a few



Fig. 30 Tuberculous tenosynovitis of dorsum of hand, history of patient given in full in text. a, b, Condition of hand previous to first operation. This patient had been operated upon three times elsewhere and scars from these operations are visible. c, d, The condition of the hand 2 months following tendon graft to replace the extensor pol-

litis longus which had been completely destroyed. This grafted tendon functions perfectly and stands out prominently on the radial side. e, f, g, The hand 2 year following tendon graft. (Four years after operation the patient writes that there has been no recurrence and that he has good use of his hand.)

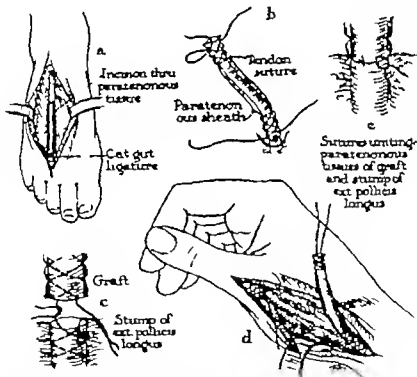


Fig. 31 Same patient as in Figure 30 Tendon transplantation for repair of extensor pollicis longus destroyed by tuberculous. a, Extensor tendon of foot exposed, leaving paratenonous tissues about 1 ft. Longitudinal incisions are made to either side of the tendon through the paratenonous tissues. At either end of these incisions cat gut ligatures are passed around the tendon and tied in order to keep the tissues attached to the tendon. b, Sutures passed through tendon and paratenonous tissues. After the suture is made the cat gut ligature and the tendon it surrounds are retracted. c, e, Details of suture lines. In (e) the suture of paratenonous tissues is shown. d, Suture at proximal line completed.

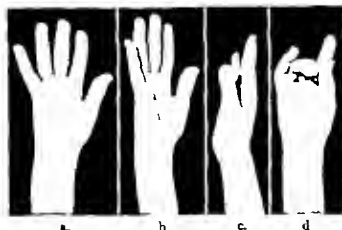
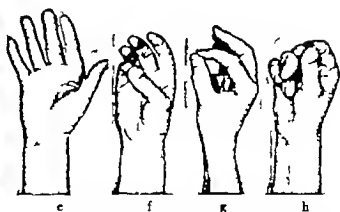


Fig. 32. Tuberculous tenosynovitis of radial and ulnar bursa with destruction of both flexor tendons of index and little fingers. These tendons were replaced by a graft of palmaris longus tendon. a, b, c, d. The hand before operation.



The limited flexion of the index and little fingers is evident. e, f, g, h. Two years and six months after removal of tuberculous sheaths and replacement of destroyed tendons by tendon grafts.

places to serve as drains. No splint is applied unless tendon repair indicates necessity for immobilization, in which case the after-care is practically the same as for tendon repair.

The treatment of dorsal tuberculosis is the same as that of the volar variety. The incisions here should be made so as to expose

the sheaths adequately and to produce a flap if possible. Since the extensor pollicis sheaths are practically always found to be infected even in those instances in which there is no external evidence of it, it is well to make the incision toward the radial side. The incision may start over the dorsum of the first inter-

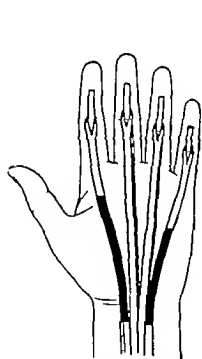


Fig. 33.

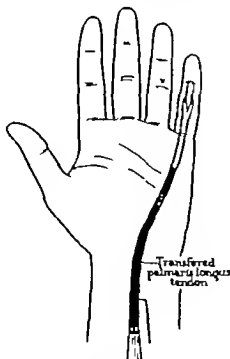


Fig. 34.

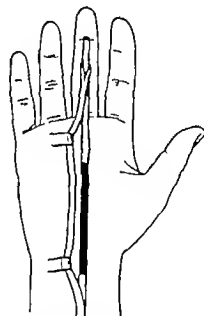


Fig. 35.

Fig. 33. Same patient as in Figure 32. The flexor tendons of the index and little fingers were replaced by tendon grafts taken from the palmaris longus.

Fig. 34. Tuberculous tenosynovitis with secondary infection. The destroyed flexor tendons to the little finger were replaced by a transference of the palmaris longus

tendon. Healing occurred in spite of a postoperative reaction.

Fig. 35. Same patient as in Figure 36. The flexor digitorum profundus to the middle finger was so badly invaded and frayed that it was replaced by a graft taken from the palmaris longus.



Fig. 10. Chronic tenosynovitis of radial and ulnar bands without extension into digital prolongations. Major complaint was of pain. a, b, Hand before operation.

c, d, e, f. Condition of the hand 3 weeks after operation. The grafted flexor profundus to the middle finger is functioning nicely.

osseus space to the ulnar side of the extensor pollicis longus tendon pass upward toward the carpus and then turn ulnarward transversely across the carpus to pass proximalward again slightly to the ulnar side of the midline for about 3 inches into the forearm.

In case of the dorsal sheath it must be kept in mind that there are multiple canals on the dorsum of the wrist through which the various tendons pass. Each of these compartments must be opened and explored and all involved tissue including the dorsal carpal ligament must be excised. It is always advisable to explore the tendon sheaths of the extensor pollicis longus, brevis and abductor pollicis longus since our experience shows that these are always invaded. At the close of the operation a new dorsal carpal ligament can be fashioned from surrounding fibrous tissue. The extensor pollicis longus which lies to the ulnar side of a ridge on the dorsal surface of the radius should be replaced in this groove and held there by suturing fibrous tissue across it.

AFTER-CARE

Unless definite indications arise the initial dressing is not changed for 48 to 72 hours. Thus we do not disturb the original hemostatic pressure of the postoperative dressing and the wound is kept free of blood and serum. At the first dressing the rubber strips are removed and another fluffed gauze pressure dressing applied. The pressure dressings

are kept up for 5 to 6 days when they may be discontinued and lighter dressings applied. Sutures as in other work dealing with the hand are not removed for 12 to 14 days. This applies particularly to the palm of the hand.

Physical therapy is not used routinely in the after-care. The patient is told to use the hand for light uses as soon as it has healed and is encouraged to spend time in the sunlight and fresh air. If good use does not seem to be returning after 6 to 8 weeks, we may advise physical therapy, heat, massage, active and passive motion for a short time. However our feeling is that such procedures are usually unnecessary and probably in view of the nature of the condition are not indicated.

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THE TYPE AND GRADE OF GASTRIC CARCINOMA IN RELATION TO OPERABILITY AND PROGNOSIS

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IN considering the therapy of any serious disease, the cause of which is undetermined, it is essential to recognize all factors having to do with the life history of the lesion. Certainly this applies to cancer of the stomach which ranks first in malignancy in regional classification. In the government reports from England and Wales and from the United States more than one third of the deaths due to malignancy are reported as cancer of the stomach.

The therapy of this disease is relatively young. It was in 1881 that Billroth first successfully resected the pylorus in an attempt to remove a cancer. In the intervening 50 years pessimism has constantly pervaded the profession, and is consequently inherent in the lay mind. There are many reasons for this, the primary one being the risk of the major procedure in any honest attempt to remove the disease and the low percentage of freedom from recurrence following surgery. But other factors contribute to the gloomy prognosis offered the victims of this disease. Foremost is the usual failure of any other form of therapy in proved cases. Radium and X ray therapy except in rare cases have not produced the arrest of the disease or even the palliative delay in distressing symptoms that can be had by applying these measures to cancer of other organs or structures.

The mimicry in its early symptomatology, of so many benign gastro-intestinal diseases and its early symptoms of mild constitutional disturbances common to so many system disorders insidiously hides the lesion in its early development and robs the victim of that essential time for surgical interference when the disease is confined to the walls of the stomach.

What is the result? The disease in its early form is suspected in only a small percentage of the cases even by the alert and intelligent practitioner, for he is the only one who sees the patients early. In the majority of cases

when the lesion is recognized only in its maturity and is corroborated by the most efficient means at our command, namely the fluoroscope and barium meal the pessimistic physician advises operation, the equally, if not more pessimistic surgeon explores and finds an irremovable growth, the pathologist later exhibits the lesion and demonstrates the disseminated metastases. A clinic or hospital without a long established and well organized follow up system will undoubtedly regard the subject of gastric cancer as hopeless. To combat this impression a periodic exhibit of all 5 year arrests after resection for carcinoma of the stomach in this clinic has been shown at the clinical pathological staff conference.

At best the operative mortality and the 10 year results are about equal in percentages—too high in the former too low in the latter. Statistics are often both boring and misleading but they are instructive, if reported from reliable sources in large enough series to warrant deductions. Table I containing the statistics of clinics in several countries is of interest.

Why do statistics vary so greatly in mortality rate and in interval results? The answer to the former lies in the skill and team work of the individual operator, the selection of cases, and the pre-operative and postoperative care of the patients. Statistics stress the importance of limiting gastric resections to individual surgeons of mature experience and demonstrated skill with permanent assistants and a well thought out program. Nowhere is this better demonstrated than in the Mayo Clinic, where these major procedures have been done by a few experienced surgeons with carefully trained assistants in an astonishingly large number of patients.

The variation in late results has to be explained, however, on different grounds. Why after recovery from the ordeal of resection do some patients live 10 years, while the ma-

TABLE I—RESULTS FOLLOWING RESECTION

Comparative statistics from various clinics regarding the percentages of 5 and 10 year arrests of the disease after resection. In some of these the percentages are computed from the entire number of resected cases. In others only the cases surviving operation are included. The latter group are marked by (a).

Year	Clinic	Basic Data	Percent-ages 5 year arrests	Percent-ages 10 year arrests
1914	Foster	85 (a)	3.1	
1915	Amesbury	41		
		45		
1916	Karman	300	1.7	0.3
1917	Perrin	100 (a)	14.5	6 (5 1-2 years)
1918	Walter	64	6	
93	Presby. Hosp. (Chicago)	20 (a)	50	
1913	Johns Hopkins Hospital	45 (a)	14.4	
1913	Presby. Hosp. (New York City)	20 (a)	75	
		(a)		3.8
93	Mayo Clinic (Baltimore)	620 (a)		50
1908	Mayo Clinic (Min. C. H.)	24 (a)	5	

majority die of recurrence within a period of 3 years or less? In an attempt to answer this question 95 gastric resections for malignancy of the stomach (including 2 of sarcoma) performed at the Presbyterian Hospital over a period of 24 years have been analyzed and compared with similar groups reported from other clinics. All but 2 of the surviving 63 cases have been followed for periods of 3 months to 18 years. This study has been aided by the constant co-operation and interest of Dr. Arthur Purdy Stout, surgical pathologist and Dr. F. B. St. John, attending surgeon, both having been interested in this subject and having reported on previous groups of gastric cancer. Dr. Stout's textbook *Human Cancer* and Dr. St. John's review of the earlier series have been frequently consulted. This discussion is based primarily upon the types and grades of malignancy in relation to operability and prognosis.

TYPES

Carcinoma of the stomach differs from carcinoma of other parts of the gastro-intestinal

tract in that the majority of the cancers are less well differentiated and are therefore more malignant. This may be due to the greater variety of type and function of the epithelial cells seen in the mucosa. The literature of the subject is confused by numerous terms used in an attempt to classify these carcinomata. Especially unfortunate are such terms as carcinoma simplex, scirrhus or medullary carcinoma or linitis plastica. No two pathologists will agree as to the exact significance of these names. The majority of such classifications have been made on the basis of the morphology of the cells and on the microscopic sections, rather than on the life history of the gross lesions.

As one sees these carcinomata under the fluoroscope, at the operating table and after resection in the fresh and in the fixed specimens, it is obviously clear that the growths fall into three types. (See Table II)

1. Those that form vegetative or fungating masses with a tendency to grow more into the lumen of the stomach than to infiltrate the coats or undergo ulceration.

2. Those that grow both into the lumen and into the wall of the stomach, with marked ulceration.

3. Those that grow into and infiltrate the coats of the stomach, rather than into the lumen and have less tendency to ulcerate.

All these types both grow toward the lumen and invade the coats of the stomach, but some the more benign and less rapidly growing tend to fungate while others tend to ulcerate as growth progresses and others, the most malignant, tend to infiltrate rather than form masses or to ulcerate.

Table II shows the relative frequency of these types and the locations in which they are commonly found. Unfortunately it is not the fungating type which is the most common of these.

The vegetative, or large fungating tumors, in this series occurred most frequently in the pars media, the ulcerating tumors were found in all parts, but most commonly in the antrum, the infiltrating type, which includes the scirrhus, the carcinoma developing on an ulcer and linitis plastica, were most frequently found in the antrum and pylorus.

TABLE II.—DISTRIBUTION OF GROSS TYPES ACCORDING TO LOCATION

In this table the gross types are distributed among the various locations. It will be noted that by far the largest percentage of fungating tumors are located in the pars media and the antrum. The true ulcerating and infiltrating growths are about equally distributed between the pylorus and antrum. The vertical and horizontal totals show the distribution of all cases among the types and locations respectively.

Location	Fungating carcinoma	Ulcerating carcinoma	Infiltrating carcinoma	Total
Pars media	8	2	3	13
Antrum	16	23	22	61
Pylorus	0	3	6	11
Total	24	28	41	93

GRADING

The possibility of grading the malignancy of carcinomata as seen in the stomach has been stimulated by follow up studies. By comparing the microscopic sections of the several types of cancer with the late results, fairly definite data can be obtained for grading malignancy. Since Broders' work at the Mayo Clinic on grading the epitheliomata of the lip first appeared in 1910, increasing interest has been shown in this subject. Martzloff has studied the grade of malignancy in carcinoma of the cervix uteri, and Greenough has done the same in malignancy of breast cancer. MacCarty has published his criteria in the grading of carcinoma of stomach and rectum, but in regard to the former, the authors have been unable to agree with his conception of relative malignancy.

The grading of malignant tumors is at best only relative and involves to a certain extent a personal factor inasmuch as it is not based upon chemical analysis or mathematical formula. But even though relative it can be of real value in its relation to the gross types of cancer and to the prognosis of the patient operated upon.

The greatest effort has been concentrated on the correlation of the gross types and microscopic sections with the clinical history and follow up results of the cases. It should be stressed that the grades used are entirely arbitrary. The criteria set forth here are offered not to determine the exact percentage of four grades but as a means of correlating the

TABLE III.—DISTRIBUTION OF GROSS TYPES ACCORDING TO GRADES

The gross types are here distributed among the four grades of malignancy. It will be seen that ulcerating carcinomata are divided between all four grades, predominating in II, III and IV. Fungating tumors are mainly in grades II and III while all of the infiltrating tumors were either grade III or IV. The horizontal totals show the prevalence of the various grades.

Grades	Fungating carcinoma	Ulcerating carcinoma	Infiltrating carcinoma	Total
I		1	0	1
II	7	7	0	14
III	10	11	15	36
IV	3	0	20	23
Total	20	18	45	83

clinical gross, and microscopic characteristics. They are by no means original, but out of many others considered as signs of malignancy, they have seemed to be most significant of carcinoma of the stomach. The following criteria of microscopic pathology have been used in determining the grade of malignancy.

1 The degree of cell differentiation. Marked deviation from the normal glandular arrangement of the cells indicates a more malignant grade.

2 Cellular activity. This is indicated by the variation in shape and size of the cells and their nuclei and the variation in cell types in the same tumor. These are considered even more significant than the number of mitoses and the chromatin content of the nuclei.

3 The invasiveness of the tumor cells, whatever their arrangement or differentiation. The invasion is to be noted in the lymphatic channels and about the nerves and vessels as well as in the muscles and the serosa.

4 The lack of cohesiveness in the tumor cells whatever their arrangement. Deibel has called attention to this in breast cancer. This is considered equally indicative of extreme malignancy in gastric cancer.

5 Metastases in the lymph nodes. This is a sign of malignancy but not necessarily an indication of the grade of malignancy. Absence of lymph node involvement greatly enhances the prognosis.

As in the epitheliomata graded by Broders it is fairly easy to divide the gastric cancers

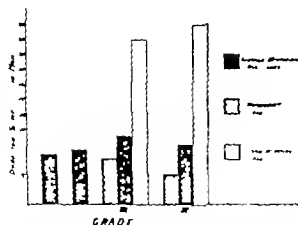


Table IV This chart represents graphically the average duration of symptoms in all grades. Taken as a whole this varies little in the different grades. If however from grades III and IV those cases with histories typical of gastric ulcer are segregated it is seen that the symptom durations fall into two clear cut groups, the fulminant symptoms of 6 months or less and the median ulcer symptoms of 2 or more months duration.

into the relatively benign and the very malignant grades. Perhaps it would be wiser to do this than attempt to separate them into four grades. In this scale of malignancy grade I merges into grade II, II into III and III into IV and there are no hard and fast dividing lines. Nevertheless it may be interesting to note the fact that both the authors in studying the sections independently and recording their individual grading against the numbers of the slides, found the grades to coincide in about 95 per cent of the cases (Table III).

There is a fairly definite relation between two of the types and the grades. That is, the vegetative or fungating type most often shows the less malignant grades I and II. The infiltrating type most frequently fall in grade IV. The ulcerating type may however prove on microscopic examination to be either grade II, III or IV.

It will be noted that the percentage of carcinoma developing on chronic ulcers has not been discussed. This question has been argued for almost 100 years since Cruveilhier first distinguished chronic gastric ulcer from carcinoma and intimated a causal relation between the two. The opinions of both surgeons and pathologists have varied so ex-

treemly on this etiological relationship that an utter lack of uniformity in the interpretation of observed facts is evident. Agreeing with the more recent writers on the subject, it is felt in this clinic that the incidence of carcinoma found associated with true chronic ulcer in resected stomachs, where microscopic sections of the entire lesion are examined, is low. In this group of 95 resections there were 6 cases. But the authors emphatically agree with Cabot and Adie, with Bucerman and with Scott in placing emphasis, not upon the percentage of carcinomata developing on an ulcer base but upon the fact that the two are so often indistinguishable in the patient. It is desired furthermore to emphasize the fact that this study has demonstrated that the carcinomata thought to have developed on an ulcer belong to the infiltrating type and are almost invariably grade IV in malignancy. In this group no patients have remained well longer than 39 months.

This has been noted in other series. Thus Bucerman in a study of 1,142 gastric cancers from the Mayo Clinic, found that carcinoma on ulcer occurred in only 0.52 per cent of the ulcerating carcinomata studied. He also states that upon the bases of Broders' classification carcinomatous gastric ulcers have a relatively high grade of malignancy 78.9 per cent occurring in grades III and IV.

OPERABILITY

The pre-operative determination of the type of tumor and grade of malignancy is a more difficult problem. This has to do with the question of operability. Our studies have brought out certain data which may be of use in this determination. Because of the inaccuracies in the case histories inherent in the varying intelligence of the patients, in the varying reaction of the patients to discomfort and their inconstant recognition of constitutional disturbances the duration of the disease is difficult to estimate. When the carcinoma is located in pain sensitive areas as in the lesser curvature or where ulceration produces bleeding the patient is more apt to seek medical advice early. Pain and bleeding are compelling symptoms and they would seem to be more often seen in the ulcerating

carcinomata found in the antrum on the lesser curvature

The duration and type of symptoms bear an interesting relationship to the grade of gastric cancer. Summarizing the average duration of symptoms in all grades it is found that in grades I and II the onset of symptoms commonly begins 7 or 8 months before the patient seeks advice from a physician. As shown graphically in Table IV grades III and IV give symptoms of slightly longer duration, namely 8 or 9 months. If the latter two groups are classified and those giving typical ulcer histories segregated, it is found that the average duration of these cases is over 20 months, while the duration of the remaining majority averages 6 months for grade III and 4 months for grade IV. In other words, patients who give a rapid, fulminating history of carcinoma are most apt to harbor a growth of relatively greater malignancy. Those which give a history suggestive of a gastric ulcer lasting over several months which progresses steadily and fails to abate after conservative treatment are likewise apt to fall in grades III and IV. On the other hand the tumors giving clinical manifestations of no great severity which develop slowly over several months are in the majority of instances grades I and II. (Table IV)

Differentiation of types is more difficult from the physical findings. The large fungating tumors are, however, more apt to be felt by the physician than the other types and with the large ulcerating carcinomata, are more often recognized by the radiologist as filling defects and less apt to be confused with gastric ulcer.

Gastric analysis frequently shows an absence of free hydrochloric acid in carcinoma but this finding is not always constant. These studies have brought out some interesting points in the relation of acidity to type, grading and result. The percentage of achlorhydria is greatest in the fungating type, least in the carcinoma-on ulcer type, greatest with tumors located in pars media, least in pylorus. The percentage of achlorhydria is inversely proportional to the ascending grade of malignancy and of the 14 cases presumably well in which the acidity was determined hydro-

TABLE V—COMPARISON OF GASTRIC ACIDITY WITH RESULT

In a comparison of gastric acidity with the result of resection as shown in this table it is interesting to note that presumable cures are about four times as frequent in cases having no free acid. In the group dying from recurrent cancer free acid was present in the gastric contents of the majority.

Result	Free HCl present	Free HCl absent	No analysis	Total
Presumably well	3	11	7	21
Dead following operation	7	14	11	32
Dead from recurrence	14	13	24	51
Total	24	37	54	95

chloric acid was absent in 11. These findings emphasize the significance of acid determinations but in so small a group of cases it is impossible to foretell their importance. (Table V) Whether this would hold true in a large series remains to be seen but it is worth considering in cases showing a palpable mass with a filling defect in the λ ray films.

A case showing a palpable tumor with filling defect in the pars media without great loss of weight and strength without a severe anemia and with achlorhydria, would be considered as a probable fungating type of grade I or II. On the other hand a case showing rapid loss of weight and strength an anemia with free hydrochloric acid present and λ ray findings showing an infiltrated wall or suggesting an old ulcer in the region of the pylorus would be considered as an infiltrating type of grade III or IV. The finding of a tumor mass that is movable without signs of fluid or a nodular liver, in an individual that is not cachectic is a favorable sign and promises well for surgery. This is especially true if the λ ray shows a filling defect in the pars media.

Golden, summarizing the roentgenological criteria of gastric malignancy as used at the Presbyterian Hospital has emphasized the difficulty in the detection of an 'early carcinoma' or one which is arbitrarily assumed to be 1 centimeter or less in diameter. He feels that such a lesion might be detected in the media by (1) interruption of the peristaltic waves on the lesser curvature (2) obliteration of mucosal folds (an observation which is hard to make with certainty) or (3) a crater

TABLE VI.—DISTRIBUTION OF GRADES
ACCORDING TO METASTASES

In this table the grades are compared with the presence or absence of lymph node involvement. It is easily appreciated that the vast majority of cases with metastases fall into grades III and IV while those in which the cancer was strictly limited to the stomach walls were about equally distributed between grades II, III, and IV.

Grade	Glands involved	Glands not involved	Total
I		2	2
II			4
III		24	26
IV	20	3	23
Total	20	29	49

shadow if the growth happens to be ulcerated. If this lesion proved roentgenographically happened to lie on the greater curvature it could be interpreted with great certainty as carcinoma. If on the lesser curvature it could only be differentiated from a peptic ulcer by a period of observation during which time it was given an opportunity to heal under palliative treatment. In the antrum, the normal peristaltic wave as such gives way to a systolic antral contraction of such magnitude that it might not be obliterated by even an extensive infiltrating carcinoma. The presence of such a growth might however be betrayed by spasm or slight rigidity of the antral wall.

It is easy to confuse the X ray picture of early carcinoma of the pylorus with that of hypertrophy and spasm of the pyloric muscle. This differentiation cannot be made with certainty without repeated re-examination and even then the constant finding of an elongated pyloric channel cannot always be taken as infallible proof of a gastric carcinoma.

The interpretation of the operative findings should further enable the surgeon to foretell the prognosis. Free fluid with nodules in the peritoneum of the omentum or of the pelvis, or nodules in the liver are of course evidence of widespread metastases and contra-indicate resection unless the nodule in the liver is single and the patient is in excellent condition. The presence of nodules in the serosa of stomach, or a beaded and granular serosa in the region of the tumor is evidence of peritoneal invasion and probably lymphatic involvement but does not contra-indicate resection nor

TABLE VII.—INFLUENCE OF METASTASES
UPON RESULT

The percentage of metastases in the resected cases are shown in this table and with it the comparative results in cases with and without metastases at the time of operation.

Result	With metastases	Without metastases
Living less than 5 years (maximum 29 months)	17	17
Living more than 5 years	0	0
Dead following operation	27	11
Dead from recurrence of growth	17	11
Total	54	42
	(55%)	(44%)

does the adherence of the tumor mass to adjacent organs such as the colon liver or pancreas, for this may be inflammatory. The colon was resected in 3 cases of this series because of the close adherence to the tumor. All 3 recovered. 1 has been living 12 years, another 4 years. Neither of these showed microscopic involvement of the colon. The third died of recurrence.

The finding of a nodule in the duodenum does not necessarily mean tumor tissue. Not infrequently have such nodules, thought at first to be carcinomatous, proved to be accessory pancreatic tissue or some other type of benign tumor. The frozen section diagnosis of such tissue is very difficult, as illustrated in the case reported by Scott. The significance of enlarged firm lymph nodes along the curvatures, around the head of the pancreas and in the gastrohepatic omentum is easily misinterpreted for such lymph nodes may be inflammatory especially in the ulcerating type of lesion. Bothe observes that the size of the nodes bears no definite relation to their involvement nor does the size of the growth have any relation to the number of nodes involved. Furthermore, the presence of metastases in lymph nodes does not necessarily indicate the grade of malignancy. Highly malignant carcinomata usually metastasize early and may reproduce in the node more than one histological type. Relatively benign tumors if allowed sufficient time will also metastasize but here the cellular structure of the metastasis is almost invariably like that of the parent tumor (Table VI.)

The presence of enlarged nodes should therefore not contra-indicate resection. Their presence is an added reason for removing as much of the attached omentum as possible in a wide resection. Not until all the excised

TABLE VIII.—INFLUENCE OF GRADE
UPON RESULT

The influence of grade upon result is here depicted. If the percentages are computed it is strikingly apparent that the presumably well cases are inversely proportional to the ascending grade of malignancy while the reverse is true in those cases dying of recurrence.

Grade	Presumably well	Post-operative deaths	Died from recurrence	Total
I	3	0		3
II	7	5	3	15
III	9	13	15	37
IV	8	5	25	38
Total	27	23	43	93

lymph nodes have been carefully sectioned can the extent of lymph node involvement be evaluated and the prognosis determined. The finding of one carcinomatous lymph node adjacent to the tumor with the others free indicates a better prognosis than when all the regional nodes are involved. Nevertheless the gravity attending lymph node involvement must again be emphasized. In this series 56 per cent of the resected carcinomata had extended to the lymph glands. None of this group of cases has lived more than 29 months after operation. On the other hand none of the patients who have lived 5 years or more had metastases to the nodes (Table VII.)

RESULTS

In some of the foregoing tables, mention has been made of the results obtained in this group of 95 cases by gastric resection. It is perhaps relevant at this point to explain the classification into result groups. Table VIII compares results with grades. It will be noticed that results have been grouped under three headings. Under "Presumably well" is included all cases living and well after resection in which no lymph gland involvement was noted. These number 21. Of these 7 have passed the 10 year mark and 9 have lived longer than 5 years. The remaining 12 have survived from 8 months to 4 years without showing signs of a recurring growth. Two of these died 18 months and 3 years after operation as a result of unrelated disease.

All patients dying in the hospital as a result of the operative procedure and its various

TABLE IX.—RESULTS OF TREATMENT

Results of treatment in all of the resected cases. It is of interest to note that of the 36 living cases only 7 had metastatic involvement of the nodes. Four of these at present show signs of recurring cancer. The 2 patients who died of unrelated causes should be classed as presumably well since at operation no metastases were found and no manifestation of malignancy was apparent before death.

Living	
Well, 10 years or more	7
Well 5 years or more	2
Living from 8 to 45 months without metastases and without signs of recurrence	10
Living from 2 weeks to 29 months with nodes involved but without signs of recurrence	1
Living, nodes involved but showing signs of recurrence	4
Total	26
Died	
From recurrence of the tumor	15
Following operation:	
Shock	11
Hemorrhage	
Infection	5
Pneumonia	11
Other causes	2
	32
Died of unrelated causes without signs of recurrence at 18 and 36 months respectively	2
Total	95

complications have been counted as post operative deaths. Of the 42 recurrent cases 35 patients have died from 6 months to 5 years after operation. Of the remaining cases 4 patients though still living are showing signs and symptoms of a recurrence. The last 3 are symptomfree at intervals of 2 weeks, 3 weeks, 5 weeks, and 29 months, respectively, after operation. It has seemed justified therefore to include these cases in the recurrent group since they had metastasized to lymph nodes and experience has shown the prognosis in such cases to be extremely poor.

To aid in illustrating these results Table IX was made to show in detail the distribution of the 95 cases among the result groups.

CASE REPORTS

The following case reports illustrate tumors typical of the three gross types and their respective grades of malignancy.

CASE 1 *Fungating type. Unit Hist. No. 42856*

Clinical features. G. A., a white male aged 50 years was admitted to the hospital on August 5, 1919 complaining of "gas in the stomach" for 15 months. This was sometimes accompanied by a dull ache in the epigastrium about 1 hour after meals and usually relieved by eating and soda. For 10 months he had been troubled by sour eructations and distention. There had been some loss of strength and during the 3 months previous to admission he had lost 10 pounds.

Physical examination revealed a poorly nourished man who appeared to be chronically ill. The abdomen was scaphoid and on palpation, a slightly tender, movable mass was felt just to the left of the umbilicus. There was also a visible protuberance in the right upper quadrant which appeared to move with respiration. The condition was diagnosed carcinoma of the stomach and operation advised. X-rays showed a large filling defect along the lesser curvature in the pars media (Fig. 3).

Operation. The abdomen was opened on the day following admission and the operator immediately felt a large hard freely movable mass in the greater curvature. Since it was nowhere attached resection was thought advisable, and carried out by the Billroth II procedure. No enlarged glands were felt and no metastases could be made out in the liver.

The postoperative course was uneventful and the patient left the hospital in good condition.

Gross pathology. The specimen (S. Path. No. 23185) consisted of a large portion of the stomach. The viscus was opened and a large cauliflower shaped growth (Fig. 2) was seen occupying the posterior wall and lesser curvature of the pars media. It projected well into the stomach cavity. It was hard but appeared to be well circumscribed. No enlarged nodes were found attached to the specimen.

Microscopic pathology. The growth was composed of hyperplastic epithelial cells growing in an alveolar manner. The tumor cells had invaded the muscle wall but had not involved the serosa. They were well differentiated, cohesive, and had not invaded the blood vessels or lymphatics (Fig. 3).

There were no metastases.

Diagnosis. Carcinoma of stomach Grade I—fungating type.

The patient has remained well for 14 years.

CASE 2. Ulcerating type. Unit Hist No. 350893.

Clinical features. F. B., a white male, aged 48 years, entered the hospital August 18, 1932. The onset of his symptoms dated back one year previously when he first noticed gaseous eructation, indigestion and occasional vomiting. These he dated from a dietary indiscretion. All symptoms gradually became worse and during the 3 months previous to admission he had suffered from diarrhea. During this time he had lost 10 pounds and felt weaker than usual and generally below par. Vomiting had increased in frequency.

Physical examination revealed a well developed, white man with a marked secondary anemia. There was felt in the abdomen in the region of the pylorus, a mass the size of a lemon which was non-tender and movable. It did not appear to move with respiration.

X-rays after a barium meal showed a characteristic irregular filling defect surrounding the antrum of the stomach (Fig. 4). There was also a 30 per cent 4 hour retention of the barium meal. The red cell count was 3,870,000 and the hemoglobin 58 per cent. Gastric expression showed no free hydrochloric acid in any specimen. Carcinoma of the stomach was diagnosed and operation advised.

Operation. Partial gastrectomy. On opening the abdomen the operator felt a large hard growth surrounding the stomach in the antrum. It was not attached to any surrounding structures and resection was thought feasible. This was carried out by the Polya method with a posterior gastro-enterotomy and entero-enterostomy.

The post-operative course was uneventful except for a partial disruption of the abdominal wound. This healed rapidly and the patient was discharged from the hospital improved.

Gross pathology. The specimen (S. Path. No. 40455) consisted of the distal half of the stomach. When it was opened a large friable growth was found encircling the antrum and partially constricting the lumen. It extended upward along the lesser curvature 5 centimeters and along the greater for a distance of 8 centimeters. The surface of the tumor was markedly ulcerated. The stomach wall was apparently not infiltrated beyond the visible limits of the tumor. No enlarged lymph nodes were felt (Fig. 5).

Microscopic pathology. The growth was composed of moderately well differentiated epithelial cells growing in a glandular form. There were large deposits of mucus and slight secondary degeneration of the epithelium. The growth had invaded the entire wall including the serosa, but the blood and lymph vessels were not involved (Fig. 6).

There were no metastases.

Diagnosis. Carcinoma of the stomach Grade II—ulcerating type.

The patient is symptom free at present one year after operation.

CASE 3. Infiltrating type. Unit Hist No. 352186.

Clinical features. H. S., a white female, aged 66 years, came to the hospital on March 7, 1932 with the primary complaint of indigestion, epigastric fullness and nausea. These symptoms had been present for 4 months and had gradually increased in severity. There had been no previous history of gastro-intestinal disorders. The last 3 weeks of the illness had been characterized by anorexia, loss of strength, and occasional vomiting. The patient had lost a total of 30 pounds in 6 months.

On physical examination the patient was seen to be a cachectic old lady with marked emaciation. In the midepigastrium could be felt a tender slightly movable mass about 7 centimeters in diameter. This shifted with respiration.

X-rays (Fig. 7) showed a filling defect involving the entire antrum and extending up onto the walls of the pars media. This apparently encircled the lumen and partially constricted it. The red cell count was 6,650,000 and the hemoglobin 81 per cent. Acid determination on specimen of vomitus yielded no free hydrochloric acid.

The lesion was diagnosed carcinoma and operation performed.

Operation. The abdomen was opened and the operator could immediately feel a rather large and extensive mass occupying the distal half of the



Fig 1 Case 1 (S P 23185) Roentgenogram showing huge filling defect primarily on the lesser curvature but also encroaching upon the lumen from the greater curvature and behind. This is typical of a fungating carcinoma

stomach. It was not grossly adherent to surrounding structures and successful removal was thought possible. Accordingly a subtotal gastrectomy was done after the Pólya-Balfour method and an enter-enterostomy.

Gross pathology (S Path. No. 47745) The distal end of the stomach was occupied by a large infiltrating tumor mass which extended from the pylorus upward for a distance of 12 centimeters on all sides. The lumen was almost occluded. The surface was indurated but not markedly ulcerated. The growth had invaded the entire wall and involved the serosa. Enlarged glands were felt along the greater and lesser curvatures (Fig 8).

Microscopic pathology (Fig 9) The tumor was composed largely of very poorly differentiated cells arising from the tips of the crypts and invading the entire wall in a non-cohesive manner. There was moderate mucous secretion but very little attempt at gland formation. The glands were involved by tumor cells of the same type. The size and shape of the cells varied greatly, and the general appearance was that of a very malignant tumor.

Metastases were noted in the superior and inferior gastric glands.

Diagnosis Carcinoma of stomach grade IV—infiltrating type.

The patient died 7 weeks after operation from a recurrence of the tumor.

SUMMARY AND CONCLUSIONS

This leads to the conclusions drawn from the study. It is evident that the division of

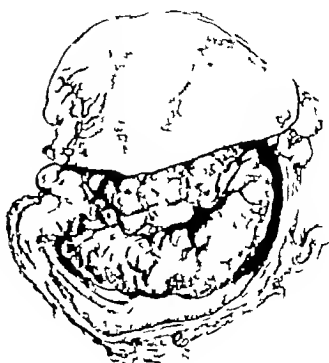


Fig 2 Case 1 (S P 23185) Photograph of gross specimen. This shows a huge fungating tumor arising from the posterior wall and lesser curvature and almost filling the resected portion of stomach. Its outlines are, however, clearly demarcated.

carcinomata into three gross types and into four grades of malignancy is an inexact classification but when taken with certain pre-



Fig 3 Case 1 (S P 23185) Low power photomicrograph. The cells are well differentiated glandular, cohesive and do not invade beyond the submucosa. There is a moderate cellular infiltration.



Fig. 4. Case (S. P. 40455). Roentgenogram showing a annular filling defect of the antrum. The outthrusts are very irregular indicating an ulcerated tumor. Moderate constriction has produced some dilatation of the antrum.

operative and operative findings these pathological criteria may be helpful to the surgeon in determining the operability and the operative procedure and to both the surgeon and pathologist in estimating the prognosis. Only when the surgeon and pathologist collaborate in the study and become familiar with the material as it accumulates will it aid them. The writers would urge that these cases be studied clinically and pathologically by a combined group of physician surgeon roentgenologist and pathologist in an effort to make the diagnosis at the earliest possible stage of the disease. Such a combined clinic would rapidly repay the time and effort put into it by the durable satisfaction of the improved results and by the increasing number of patients that will be referred or who voluntarily come to such a clinic, the reputation of which will rapidly spread. In such a clinic both benign and malignant lesions of the stomach should be studied by the group and all follow up visits be seen. It is the return visits of patients bringing with them their

results good or bad whatever the therapy applied that make the members of the team speak the same language and agree upon definite therapeutic policies.

For such a combined gastroduodenal clinic the authors feel that a modification of the plan first suggested by Scott would be highly advantageous. This embodies a clinical classification of gastric ulcers whereby the possibly malignant cases are definitely segregated and given the closest of attention. This classification contains four groups as follows:

I—Ulcer suspect

II—Ulcer verified

III—Ulcer verified carcinoma suspect

IV—Ulcer verified carcinoma verified

Group I includes a large number of cases whose clinical story suggests ulcer but in which there is no confirmatory evidence. In a large majority of these the symptoms do not permit the localization of the lesion hence they must of necessity be classed loosely as peptic ulcers. Many no doubt are due to the ulcer mimicking symptoms of other upper abdominal pathology. Hence as Moynihan has pointed out it is far better to have any critical study of gastric ulcer on cases in which the diagnosis has been proved by operation or X-ray. This group is therefore of use primarily in differential diagnosis and their treatment should be limited to palliative measures.

Group II contains only those cases in which the clinical impression of gastric ulcer has been confirmed by roentgenological studies. Upon these patients conservative treatment is concentrated ambulatory if possible hospitalization if necessary. They are to be watched closely for definite signs of improvement or exacerbation. Those which respond favorably to conservative treatment are maintained in this group although they should be observed closely for indications of a recurrence through the medium of the follow up clinic. This observation cannot be overemphasized for it is not at all unusual for an ulcerating carcinoma to show signs of improvement after hospitalization and medication. If symptoms are not markedly abated or if they increase the patient must then be passed on to group three.



Fig 5. Case 2 (S P 49455) Photograph of gross specimen. This shows a huge ulcerating tumor surrounding and constricting the antrum and pylorus. The growth has not extended beyond the pylorus and the proximal border is well marked.

In group III ulcer is verified cancer is suspected. Further treatment varies with the physician or surgeon but this is the stage at which exploration is of most value and resection should be done if there is to be the hope of removing the early cancerous lesion before it has disseminated. No doubt many benign ulcers are resected in this stage but in view of the low operative mortality attending gastric resection for benign ulcer and the possibilities for removal of a potential cancer one can hardly doubt the efficacy of the procedure.

When the lesion has been proved carcinoma, beyond reasonable doubt, the patient passes into group IV. This differentiation can in rare cases be made by the roentgenologist who notes a rapid increase in the size of the lesion with an appreciable filling defect. More frequently the operator who explores finds evidence of infiltration and invasion, sometimes with lymph node involvement which bespeaks the presence of malignancy. But most often it is not until the lesion is examined beneath the microscope that the cancerous nature is recognized and the justification par excellence for resection is established.

We have discussed the difficulties of early diagnosis for carcinoma of the stomach in



Fig 6. Case 2 (S P 49455) Photomicrograph. The tumor is composed of glandular epithelium which is cohesive, well differentiated and actively secreting mucin. There is evidence of degeneration in the epithelial lining of the mucinous cysts.

general. The delay in diagnosis in the fungating type is not so serious as in the other types. Both the fungating and ulcerating types coming to resection are diagnosed by X-ray study in well over 90 per cent. But there are two groups of cases that are most difficult to diagnose in the early stage. One is the infiltrating type of carcinoma, appearing in the patient with no past history of digestive disturbances, with the first symptoms those of constitutional disorder—loss of energy, appetite, and weight and fatigability or with epigastric discomfort but with negative barium X-ray studies. This insidious lesion almost always remains confined to the gastric wall interfering so little with normal gastric function that when constitutional symptoms first arise the stomach is rarely suspected as the source of trouble.

The second difficult group is composed of patients giving a previous history and X-ray diagnosis of gastric ulcer but with insidious symptoms of a change in the character of the epigastric pain and a failure of diet to control it or in the appearance of the constitutional disturbances shown by slight loss of energy.



Fig. 7. Case 3 (S. P. 47745). Roentgenogram showing a constricting antral defect. Note the smooth outline of the stomach wall in contrast to the irregular shadow in Figure 4, indicating a tumor of the infiltrating type.



Fig. 9. Case 3 (S. P. 47745). Photomicrograph showing normal mucosa in lower right hand corner from which tumor cells are arising. Mucosa is being produced. The cells are poorly differentiated, non-cohesive and invasive.



Fig. 8. Case 3 (S. P. 47745). Photograph of the gross specimen showing extensive invasion of the stomach wall by tumor. The viscera has been converted into a rigid tube and the surface is pebbled and granular but not ulcerated.

appetite and weight. Again this carcinoma is of the infiltrating type and of a highly malignant IV grade. If the clinician waits until the X-ray studies are undoubtedly positive for carcinoma the growth will in all probability have extended beyond the confines of the stomach.

The criteria of Lahey and Jordon (17) for the limits of conservative treatment in these cases are well worth noting. They require that within a period of 3 weeks symptoms be completely relieved, that the lesion by repeated X-ray study must show definite decrease in size, and that blood disappear from feces and gastric contents. Maes has well summarized this important therapeutic problem.

"The only safe plan is to regard as cancer any indigestion, with or without symptoms, which appears after middle life in a previously well person; to regard as cancer any acute digestive disturbances, in this period, which are superimposed upon chronic digestive disturbances and which do not respond to routine measures; to regard as cancer or highly sus-

picious of it vague general symptoms of fatigue, malaise, mental indifference, insomnia etc., even though associated gastric disturbances are lacking to continue to regard as cancer any one of these clinical syndromes until it is proved beyond the shadow of a doubt not to be cancer and to resort without delay to exploratory laparotomy. If the diagnosis cannot be made otherwise. In malignant disease the certainty of diagnosis is frequently also the certainty of death.

Again as Arthur Curtis remarks

It is better to have a less accurate diagnosis and a more favorable prognosis

Certain it is that only by operating on these infiltrating types of cancer before the tumor cells have passed beyond the stomach walls, will the victim be saved. The earlier the surgical attack the better the prognosis.

In conclusion it is to be emphasized that only by becoming familiar with the life history of the different types of growth and grades of malignancy in carcinoma of the stomach can we arrive at an estimate of the relative operability and prognosis in this dreadful disease.

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CANCER OF THE COLON

NOTES ON ITS SURGICAL TREATMENT¹

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WITH the exception of the small group of cases which present themselves with acute intestinal obstruction cancers of the large bowel may be relegated in so far as their surgical treatment is concerned into the category of chronic ailments. This is of not inconsiderable significance in that it allows a time to institute preliminary measures aimed at increasing safety factors in the extirpation of these organic lesions. Obstruction unquestionably is present in the vast majority of cases of carcinoma of the large bowel at some time during their existence varying in degree from the chronic variety to acute stenosis.

Burgess of Manchester reviewed a large series of cases of acute intestinal obstruction and noted that one-third of all cases resulted from acute stenosis of the large bowel. His statistics showed moreover that if one excluded hernias and intussusception and localized the lesion to the colon there were nine chances in ten that it was a cancer. Further more this type of obstruction almost invariably occurred in the left colon. The reason for the difference in occurrence of obstruction in the right and left halves of the colon is not only the type of fecal content and anatomical construction of the bowel wall but also the pathological variety of growth encountered. The scirrhous carcinomata of the left colon have a tendency to encircle the bowel lumen. The cancers on the right side usually are flat ulcerating do not encircle the bowel are larger in caliber and more elastic and the fecal content is liquid.

In a not inconsiderable experience I have only twice operated upon acute intestinal obstruction due to cancer of the right colon and in both instances the growth was situated at the ileocecal valve rather than at the juncture of the cecum with the ascending colon which is the common location.

As a rule, obstruction is slow and progressive and for that reason a chronic undermin-

ing of the individual's resistance a progressive dehydration and desiccation and intoxication take place because the cancer of the colon has been present for a period of nearly a year before the individual seeks advice. To combat such a situation the institution of preliminary rehabilitative measures, as well as decompression of the bowel are most advantageous. Consequently one may divide the phases of the surgical offensive against cancer of the colon into one of preliminary preparation operative and convalescent periods. Of these three phases the first is by no means the least important in its influence upon hospital mortality and operability. To increase the individual's resistance and to decompress the colon itself is the aim of this preliminary preparatory period. One might epitomize the steps in this sequence by saying that decompression hydration vaccination and rehabilitation constitute preliminary preparation.

We have found it advantageous to attempt to decompress chronically obstructed colons by the employment of mild purgation and bowel irrigation over a period of from 3 to 6 days. In the vast majority of instances even when the obstruction is of the subacute variety one will be rewarded with finding a clean flat colon at operation. I take it that it is perfectly understood that no attempt to decompress an acutely obstructed colon by other than surgical methods is ever attempted. To do so is folly and from the patient's standpoint fatal. Chronic colonic obstruction may be well borne for a considerable period however and repeated efforts to relieve the bowel of its content are well worth while persisting in for a time. The warm irrigations of normal saline not only rid the bowel of its content but secondarily they reduce the infection around the growth which is an important circumstance.

Obstruction and ulceration as Herrman has pointed out increase enormously the permeability of the bowel wall and consequently

extravasation of infective organisms into the pericolic tissues takes place. This is the process from which lethal peritonitis most often develops. The graded operations which permit sidetracking of the growth or irrigation of the bowel likewise assist in reducing this infection during the interval between stages.

While decompression is taking place, hydration is accomplished by blood transfusions and the ingestion of large quantities of fluids, particularly fruit juices. Within the past year I have routinely employed blood transfusions in all cases of cancer of the colon and rectum before operation and I believe that it is decidedly advantageous. I have not been governed by the hemoglobin index in this matter but have felt it decidedly helpful even when the general condition of the individual seemed fairly satisfactory. A high caloric diet low in residue is likewise employed.

The routine use of an intraperitoneal vaccine of streptococci and colon bacilli was begun by Bergen and me in 1927 and has been continued advantageously up to the present time. Theoretically this measure should increase the resistance of the individual to infective organisms which are so uniformly present in the pericolic tissues and about the growth itself. We reported a series of cases in which there was a large difference in the mortality rate between the group of 60 cases of carcinoma of the colon, vaccinated before operation and a control group of unvaccinated patients operated upon by the same surgeons. Subsequently in 1931 we reported 222 cases of carcinoma of the colon and rectum, in which the patients were vaccinated and operated upon between January 1 and October 1, 1929 and 58 cases in which operation was done during the course of these months under similar conditions but without vaccination. In the large group 11 deaths occurred from peritonitis while in the small group 13 deaths occurred from peritonitis—a mortality of 4.9 per cent versus 22.4 per cent. I do not believe that vaccination accounts for the entire improvement in the hospital death rate. That it had a favorable influence seems to me to be obvious but to abandon all other preliminary measures, as well as careful operative selection

of cases in favor of its use would, I think, be foolhardy. However as a step in the sequence of events aimed at increasing the individual's resistance to infection I feel that it has proved of distinct value. Certainly there are no disadvantages to its employment.

SELECTION OF CASES

The selection of cases for operation involves the exercise of mature surgical judgment if one is to extend the horizon of operability and extirpate colonic cancers with a reasonable hospital death rate and the hope of satisfactory ultimate results. While operability must be a flexible term with distinct shadings in different hands, there are three general principles which I believe are fundamental in the acceptance or rejection of a given case for radical operation: namely, first, hepatic metastasis; second, excessive local fixation to the abdominal parietes or adjacent viscera; and third, the general resistance of the host as evaluated in terms of resistance to formidable operative procedures. In the first of these factors—hepatic metastasis—there is no question of rejection for radical operations yet in a small group of cases in which the local growth is readily removed by some type of operation without too high a mortality, I believe the resection is justifiable because of the painlessness of death from liver metastasis in contradistinction to the unhappy demise from a fixed ulcerating painful cancer. That this group is extremely small, cannot be denied, but occasionally I have felt it worth while to remove an obstructing cancer which is freely mobile but inoperable in reality because of liver metastasis, in the belief that the period of life thus given the individual is made more worth while.

Fixation to adjacent viscera or the abdominal wall may, under drainage procedures, loosen sufficiently in some cases to allow a secondary resection at a later time. One should remember that fixation usually comes from inflammation rather than from malignant extension. With this in mind a growth considered as border line or inoperable at the exploration, may eventually become sufficiently mobile after the recession of the inflammatory process to allow removal.

Again there is a group of cases in which local fixation to adjacent viscera such as the bladder or uterus demands multiple resections such as complete hysterectomy or partial cystectomy in addition to resection of the colon. I have operated in a number of such cases without increasing the mortality but with unsatisfactory ultimate results. I believe however that such cases may be selected with justification under certain circumstances and that it is distinctly worth while to give these individuals a period of comfortable existence and let them return to their work. If it may be done without too much operative risk. Such procedures should always be considered as palliative and as involving a high operative risk. Indulgence in speculation on the percentage of operability in different hands, must necessarily be done with considerable trepidation because of the many factors concerned. My own experience has been that an operability of one out of two cases is about what may be maintained over a period of years. Occasionally it will run as high as every two out of three but more frequently one finds the fifty per cent range fairly accurate. That this should be maintained with an operative mortality ranging from 5 to 10 per cent leaves the impression that this is a satisfactory standard in this particular field.

OPERATIVE MANEUVERS

That a graded operative procedure should be employed most often in extirpation of colonic growths is, I believe the experience of most surgeons. That there are disadvantages to this type of procedure cannot be readily denied yet the advantages seem to me distinctly to outweigh them. Technically choice in operations on the two halves of the large bowel differs because of the type of pathological processes present, the presence or absence of obstruction and local complications such as fixation, abscess formation and attachment to adjacent viscera. Nevertheless, because of the greater safety of multiple stage procedures despite the numerous problems involved as well as the inconvenience of two laparotomies, I believe their value is proved. In the right colon my choice is an ileocolostomy and exploration at the first stage followed by a sub-

sequent resection of the right half of the large bowel. If it seems advisable to accomplish the resection and anastomosis in one stage I believe unquestionably that a complementary ileostomy proximal to the anastomosis should be done. I have many times in operating for hyperplastic tuberculosis of the ileocecal coil resected the right colon in one stage and occasionally I have attacked carcinomata by a single operation but as a rule I believe the hazards are too great to undertake it except in highly selected cases.

The ileocolostomy which is done at the preliminary stage of the multiple maneuver plan accomplishes a drainage which in turn permits recession of the inflammatory process around the growth and also is of great advantage in the patient's rehabilitation increasing his resistance against another formidable extirpative act and simplifying at the same time the secondary procedure. In performing the ileocolostomy I would emphasize the desirability of making the anastomosis end-to-side between the terminal ileum and the transverse colon. My own choice is to do this over a clamp which I have designed making an aseptic type of juncture. This aseptic end-to-side anastomosis over the clamp is simple of accomplishment, and I think possesses definite advantages. The instrument is not cumbersome. The procedure may easily be done by anyone and in an experience of 100 consecutive cases which include in addition to our 60, those cases reported by other surgeons, there has not been a single postoperative hemorrhage. This is an objection frequently offered against anastomosis done over crushing clamps. In my own series there has been no instance of obstruction at the site of anastomosis nor has there been any leakage at the suture line although two patients died and autopsy revealed evidences of peritonitis in one. In this case there was no leakage and it was the conclusion that the peritonitis came from the large infected growth.

In my series of 62 ileocolostomies there were four operative deaths, a percentage of 6.4. While I do not believe that the aseptic type of anastomosis is of paramount importance there is little question that the cleaner the anastomosis, the less likelihood of subac-

quent contamination and consequently if one may do this anastomosis with the ease and comfort with which an open anastomosis may be accomplished and without complications of obstruction and hemorrhage, the advantages are definite. Like vaccination I consider the aseptic type of anastomosis as but one of a sequence of events aimed at successful surgical attack on right colonic cancers. Of the utmost importance I think, however is the manufacture of an end-to-side opening between the terminal ileum and the transverse colon to by-pass the fecal current, thereby reducing the local infection, intoxication, and dehydration, and the promoting with other measures, of rehabilitation.

The second stage of this maneuver is carried out at a later date with from 2 to 6 weeks intervening as a rule. This is easily done with exploration having been made at the first operation and the resection being the main matter in hand. At this time one mobilizes the right colon ligates its blood supply divides it between clamps with a cautery turns in the end of the bowel and peritonealizes the raw surfaces quickly. It is best to drain the retroperitoneal pocket left because of the tendency of serum to collect in this space and the likelihood of it becoming infected and forming an abscess.

When the growth is situated beyond the middle of the transverse colon down to as far as the juncture of the middle and lower thirds of the sigmoid the choice of operation in my hands has been an obstructive type of resection when a chronic or subacute obstruction has been eliminated by pre-operative precaution. Let me emphasize the desirability of complete pre-operative decompression of the bowel before this type of maneuver is employed. This obstructive resection however utilizes all the satisfactory fundamental principles of the extirpation operations and avoids most of their disadvantages. In mobile segments of the large bowel it has proved most satisfactory in my hands. By mobilizing the bowel accurately ligating the blood supply in the mesentery and removing the lymphatics and gland bearing tissues in the immediate vicinity of the growth one may in this manner perform just as radical a resection

as may be carried out by any type of procedure. The three bladed clamp is left on the ends of the bowel, and the toilet of the peritoneum completed, leaving the colon completely obstructed for a period of 48 to 60 hours. At the end of this period the proximal blade is released. If gas has formed in the colon it blows open the colostomy, otherwise it may be necessary to pick it open with tissue forceps.

The subsequent steps of the operation are completed exactly as in the Mikulicz procedure. We have found these wounds singularly free from infection and with a tendency to close spontaneously at the end of about 2 months if enough spur has been removed between the two stomas, and the mucous membrane has not been left attached to the skin.

There is a distinct advantage in employing the Mikulicz operation occasionally, but I feel certain that its limitations are much greater than are usually conceded by most surgeons. It is impractical in cases of adherent growths associated with infection of the bowel wall and adjacent tissues and large growths associated with infection or obstruction, and for growths in a sigmoid with a short mesentery or in obese patients. My own application of it is in thin elderly individuals without obstruction possessing a carcinoma in a mobile segment of the large bowel and yet physically unable to stand any extensive operative act. Usually this type of case can be best explored under local anesthesia, the bowel brought out on the abdominal wall and the wound closed loosely around it. I think that it is never desirable to ligate the blood supply of the segment of the bowel to be sacrificed in order to make it mobile enough to perform an extirpation operation. Under these circumstances the growth and the loop of bowel in which it is situated early become black and foul-smelling and infection quickly takes place not only in the abdominal wound but occasionally reaches into the peritoneum causing peritonitis.

Where neither an obstructive resection or some type of resection and anastomosis can be done because the bowel is insufficiently decompressed it is desirable to perform either a caecostomy or a colostomy as a drainage

measure. Subsequent resection of the colon may then be carried out either as, first, a resection and anastomosis or second, as an obstructive resection. Cecostomy as a drainage type of maneuver preliminary to subsequent resection of the left colon or rectum is a most desirable procedure. If one uses a large Pezzer catheter and introduces it into the cecum after Hendon's method, one is able to decompress the bowel sufficiently in a period of from a few days to a few weeks. It has the distinct advantage of placing the artificial stoma away from the wound through which the second stage is performed.

Whipple very aptly summarizes the advantages of cecostomy as a preliminary measure as follows: (1) it makes possible proper cleansing of the colon before resection (2) it permits the part anastomosed to be at rest until the period of fibroplasia is complete (3) it increases the comfort of the patient by reducing the pain of ineffectual peristalsis (4) it obviates the temptation and necessity in some cases of giving enemas and irrigations in the critical period of repair (5) in cases of partial or complete obstruction of the colon and rectum it has long been recognized as essential and if it works so well for patients who are so desperately sick, it is even more efficacious in the case without obstruction.

I have not felt inclined for a long time to attempt a primary resection and anastomosis in the left colon with or without complementary decompression. While I feel certain that many times this may be safely done I believe the attendant dangers of primary anastomosis are too high to employ it in anything like a routine manner. The blood supply of the colon is constant but scanty as compared with that of the stomach and small bowel. Infec-

tion is always present to retard rapid healing as has been shown by numerous investigators who have measured the rate of healing of various tissues.

There is danger of necrosis at the danger line of leakage. The question of secondary resection of the left colon then resolves itself in deciding whether or not to resect and anastomose or to do an obstructive resection at the second stage. My own experience in doing an obstructive type of resection at the second stage has been a satisfactory one and I have found small additional risk in closing the two stomas subsequently over the closing of a single one.

These graded procedures both in the right and left halves of the colon, may be undertaken as a general rule, with a hospital mortality rate ranging from 5 to 10 per cent without sacrificing the operability ratio which should rarely be lower than one out of two or which occasionally may run as high as two out of three cases. That the prognosis is favorable, is easily demonstrated, yet there is ample opportunity for improvement if one may receive these cases at an earlier period in their development.

I believe that it is undeniably true that more patients with carcinoma of the bowel and rectum are appearing at an earlier stage yet the average of ten months or more of symptoms prior to examination leaves much to be desired. Roentgenographic efficiency in the diagnosis of organic lesions of the large bowel has been markedly forwarded in the last decade. Improvements in technique have followed the diagnostic pace and a better understanding of pre-operative and post-operative management has reduced the mortality curves.

FRACTURES OF NECK OF FEMUR, DISLOCATIONS OF HIP, AND
OBSCURE VASCULAR DISTURBANCES PRODUCING
ASEPTIC NECROSIS OF HEAD OF FEMUR

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THE structure of the hip is such that certain types of injury are particularly apt to damage blood vessels to the head or head and neck of the femur. Because of inadequacy of collateral circulation this may result in aseptic necrosis of the bone and articular cartilage supplied by the damaged vessels which is an important factor in the causation of non union of fractures of the neck and flattening and other deformities of the head, with their poor functional results. Santos reported earlier studies on the subject in this clinic and the present report deals with a continuation of that work. Interference with the blood supply of the head of obscure origin also results in similar necrosis and breaking down of head especially during childhood. Aseptic necrosis is responsible for deformities and poor functional results in fractures of other bones bordering on other joints, as of the carpal navicular and the body of the astragalus, as previously reported (18).

The head and medial three fifths of the neck of the femur lie within the cavity of the hip joint. The round ligament connects head with acetabulum. The intra articular portion of the neck is covered by a capsule which during the major period of longitudinal growth functions as periosteum but which in adult life is almost completely devoid of osteogenic properties. The head and neck considered as a unit may receive blood supply from three arteries namely the posterior cervical the anterior cervical, and the round ligament. It is generally agreed that the blood supply of the neck is derived from the cervical arteries, largely the posterior cervical, but when the blood vessels of the head are considered, there is much disagreement as to the relative importance of those coming by way of the round ligament, the capsule of the neck, and the interior of the neck also as to the extent and location of anastomosing and end arteries during both

the periods of growth and adult life. In fact the anatomical, pathological and animal experimental evidence which has accumulated since Sir Astley Cooper, in 1820, first called attention to the subject, would indicate that there is a good deal of variation in these vessels with the individual.

In the newborn, studies of the injected vessels with roentgenograms or after clearing by the Spalteholz method, show round ligament and capsular arteries sending branches into the cartilaginous capital epiphysis. After the appearance of the center of ossification there is a difference of opinion as to the extent to which each of these arteries penetrates it. Langer and Lexer from injection experiments, thought that they demonstrated arteries from the round ligament which were of importance for its blood supply during the period of growth. They also found injected vessels within the head coming from the superior and inferior neck arteries of the capsule, and from arteries within the neck which penetrate the cartilage plate to reach the center of ossification. Nussbaum (15), in similar studies, found few or no injected vessels of the head coming from the round ligament, and none penetrating the cartilage plate from the neck. He thought that the vessels of approximately two-thirds of the head came from the superior neck artery and of the remaining third from the inferior neck artery.

As to anastomoses and end arteries during the period of growth Langer considered that both metaphysis and epiphysis contain end arteries but that there are also anastomoses between the primary arteries of each region. Nussbaum (16) from studies of injection specimens has recently claimed that the metaphysis contains end arteries but that none are present in the epiphysis. Reports of the results of animal experiments are conflicting. Division of the round ligament in young

animals in some instances has produced necrosis of bone adjacent to the fovea but not in others. Bonn and Stewart found little or no necrosis after division of round ligament and no subsequent flattening of the head. Nussbaum reported necrosis and flattening of the bone of the head and thickening of the articular cartilage. Zemansky and Lippmann found slight necrosis in each of 7 rabbits, 1 of which showed flattening of the head after 35 days.

Experimental bland embolism as reported by Wollenberg and localization of pathogenic bacteria, which presumably often results from embolism, are rarely observed in the epiphyses but are seen in the metaphyses. This speaks against the existence of end arteries in the epiphyses and for their occurrence in the metaphyses. Metaphyseal foci only were observed by Lexer after injections of staphylococci, and by Schulze after injections of tubercle bacilli.

Stewart found that cutting both round ligament and vessels of the capsule of the neck in young animals results in necrosis of the bone of the capital epiphysis more frequently and more extensively than division of round ligament alone but even then in both dog and rabbit it often fails to follow. In such cases there must be anastomoses between the internal vessels of the neck and the epiphyseal vessels. These may penetrate the epiphyseal cartilage plate, as claimed by Lexer and Schulze or pass about its periphery.

In adults there are definite anastomoses between the vessels of the interior of the neck and head. Consequently the head is less dependent upon the vessels coming by way of the neck capsule. Capsular vessels are present although in some cases they are small and of little service in nourishing the head as shown by death of head in fracture of neck, even though much of the capsule is untorn (Schmorl).

As to vessels entering the head by way of the round ligament during adult life, it is now established that they are present in the majority of cases but that their size varies greatly. Chandler and Kreuzer recently studied 114 round ligaments from cadavers of persons ranging in age from 25 to 75 years. Arteries were found in all of them. Fifty ligaments

showed vessels with lumina ranging from .04 to 1.05 millimeters in diameter. Microscopic sections of the fovea were made in some cases and the vessels were seen to enter the bone. They were of sufficient size to be of importance in supplying blood to the head. In the remaining ligaments the arteries ranged downward in size to pre-capillaries and in many cases were too small to have played an appreciable rôle in supplying blood to the head.

The existence of end arteries in the bones of adults has been generally denied by those studying the subject purely from an anatomical standpoint. Necrosis and collapse of the head of the femur following dislocation of the hip in adults as reported by Chandler and Kreuzer and by Stewart, and in this article proves the existence of end arteries in that region. Axhausen (3) also found infarcted areas in the tibia and femur of an adult as a result of vascular blockage.

Turning from these anatomical and experimental data to study certain injuries and diseases of the hip in man we discover important facts about the blood supply of the femoral head and the results of its injury which could scarcely be elicited in any other way since experiments happen in nature that cannot well be duplicated in experimental animals. They will be considered under the head of fractures, dislocations, slipped epiphysis, injuries to vessels alone, and disturbances of vessels of unknown cause.

FRACTURES

The fractures causing necrosis may be of the intracapsular or extracapsular portions of the neck or of the greater trochanter. The last two are extremely rare.

Intracapsular fracture of the neck of the femur. In this injury the blood supply of the head may be maintained through vessels entering by way of the round ligament or untorn portions of the capsule or by both. It may also be either partly or completely destroyed in case the vessels coming by way of the neck are completely severed and those of the round ligament are too small to maintain the circulation. In that case a part or all of the head of the femur becomes necrotic. In the case of either survival or death of the head, the frac-

ture may unite or remain ununited. Consequently the result will be one of four conditions (1) survival of head with bony union, (2) survival of head with non union, (3) necrosis of head, partial or complete, with bony union, (4) necrosis of head, partial or complete, with non union.

It is generally recognized that it is possible to determine in 2 to 4 months by clinical and roentgenological examination whether or not bony union has occurred. However, an important fact not generally recognized is that it is also possible to determine from roentgenograms in 2 to 5 months in the great majority of cases especially of non union whether head has remained alive or has undergone partial or complete necrosis. This information has been derived by correlation of roentgenological studies of fractured hips with roentgenological and pathological studies of heads obtained at operation or entire upper ends of femurs obtained at autopsy on these cases. Seventeen specimens of fractures from 15 days to 4½ years after injury have been studied in this way. They were obtained at operation in 14 cases and at autopsy in 3. Pathological examination showed survival of the head in 3 cases and partial or complete necrosis of it in 14. The roentgen diagnosis is possible because recognizable differences in density develop between the dead and living portions, and there is slow creeping replacement of the dead bone by spongy living bone of low density.

Since these diagnostic methods have been used, 49 cases have been studied in which sufficient time had elapsed to make it possible to say from roentgenograms, and in 17 of the cases from pathological examination whether the head was alive or necrotic, and whether there was union or non union. The results were as follows: survival of the head—17 cases, with union in 8 cases and non union in 9, necrosis partial or complete of the head—32 cases, with union in 4 and non union in 28. Thus, there was bony union in 25 per cent of all cases. The head survived in one third of the cases and there was bony union in approximately half of these. In two-thirds of the cases the head underwent partial or complete necrosis, and there was bony union in only one seventh of these. This shows the great

importance of necrosis in the proximal fragment as a cause of non union of intracapsular fractures of the neck of the femur. However the series most probably gives an exaggerated picture of the frequency with which necrosis of the head of the femur occurs, since it does not represent a series of fresh cases, most of them were studied long after the hip fractured because of a bad result, and when non union was found to exist.

INTRACAPSULAR FRACTURE OF THE NECK WITH SURVIVAL OF THE HEAD AND BONY UNION

Knowledge of the subject has been derived largely from long term roentgenological studies and pathological studies of recent cases, only 1 late case No 12 of Santos, having been studied pathologically.

The fracture is in the mesial portion of the neck. In the great majority of cases of intracapsular fractures of the neck, regardless of whether the head remains alive or the fracture unites the periosteum or capsule of the neck is torn in only a part of its extent (Schmorl), the posterior portion being especially apt to remain intact. The blood supply of the head is preserved by the vessels of the round ligament or/and of the untorn portion of capsule. It is difficult to say which of the two is the more important. Three fractures of the neck with survival of the head, in this series, were studied at autopsy 15 to 24 days after injury, and all were found to have a portion of the capsule untorn. Transverse sections of the untorn capsule in 2 cases showed vessels that were large enough to play a considerable rôle in the blood supply of the head. Figure 1, Case 1, gives some idea of the extent of untorn capsule that may be present. It shows an intracapsular fracture of the neck in an 80 year old man who died 3 days after injury. In the anterior view the fracture and intact round ligament and in the posterior view the untorn portion of capsule are shown. While it was too early to determine whether the head was dead or alive, microscopic examination of the untorn capsule showed the presence of blood vessels of considerable size.

The sequence of pathology when the head remains alive and union takes place is as follows. The apposition and fixation of fragments

is usually satisfactory as otherwise non union is the result. Union occurs most often when the fracture is impacted. Necrosis of cortex of both fragment ends for a short distance back from the fracture is to be expected as it is a regular occurrence in fractures of other locations, as shown by Cornill and Coudray. It was observed in Cases 2 and 5 of this series in which the time elapsed was sufficient for disappearance of the dead bone cells but insufficient for erosion of the end of the distal fragment. In some cases bony union occurs with preservation of neck fragments, especially when there is impaction. The callus forms almost entirely within the neck, the periosteum showing practically no osteogenic activity. The callus ossifies and practically no deformity is left except that which results from angulation of fragments. Thus and the increased density at the fracture line make it possible to locate the seat of the fracture in roentgenograms in some cases years after healing has occurred. Atrophy of disuse develops during the period of immobilization and healing. This is evenly distributed being as marked in the head as in the distal fragment and acetabulum. The head never collapses and the articular cartilage is not destroyed. With resumption of function after union is complete the bone gradually increases in density and after several months the density may return to normal. If the position of the head has been much altered new trabeculae will be formed in it along the new lines of weight bearing. Increasing age does not appear to lessen the frequency of survival. In one case there was bony union and survival of head in a woman aged 66 years, as shown by a series of roentgenograms during 4 succeeding years.

The X ray diagnosis of survival of head and bony union may be made on the following points. There is uniform reduction of density of all of the bones of the hip during the period of immobilization and healing the change being as marked in head as in distal fragment of femur. Density develops along the fracture line from callus formation. With resumption of function the density of the bones gradually and uniformly increases until it is as heavy as before. There is no sign of collapse of the head or narrowing of cartilage space of joint.

Figure 2 is a roentgenogram of the hip of Case 14, reported by Santos showing the condition 5 years after fracture. The function of the hip is normal. The head is angulated slightly outward and there is an irregular line of increased density along the site of the old fracture. The density is of the same degree and uniformity in the head as in the shaft and the shadows of articular cortex and cartilage space of the joint are intact.

The pathological changes in the early stages of neck erosion are illustrated by Case 3.

A female, aged 75 years, fractured the neck of the right femur 15 days before death. In addition to the fracture of the neck the capsule was torn anteriorly but the posterior portion of capsule was intact. The distal fragment was upwardly displaced and its cortex had gouged into and eroded cancellous bone of the proximal fragment. This is shown in a microscopic section through head and neck (Fig. 3). Microscopic examination showed the bone alive in both proximal and distal fragments except along the fracture lines. There was death of cortex of the distal fragment for $\frac{1}{2}$ to 1 centimeter back from the fracture line. Fibrous callus filled the cancellous spaces on both sides of the fracture to a depth of $\frac{1}{2}$ to 1 centimeter and bony trabeculae along the surfaces were dead, fragmented, and in many places ground into the underlying cancellous spaces as shown in Figure 4.

Erosion of the neck was well under way in this case, and there was considerable necrosis of cortex of the distal fragment adjacent to the fracture line. Non-union might have been the result but delayed union after more erosion of the neck might have occurred.

In other cases of fracture of the neck with survival of the head the neck fragments may be extensively eroded over a period of months as a result of incomplete fixation and friction. Callus may then be thrown out and bony union between the head and stump of neck may take place giving a satisfactory functional result. This was true in Case 12 of Santos series which was confirmed at autopsy 4 $\frac{1}{2}$ years after injury.

CASE 3. This illustrates survival of the head with markedly delayed union and partial erosion of neck fragments. A female, aged 56 years fell on the left hip and sustained an intracapsular fracture of the neck (Fig. 5). Treatment was by the Whitman abduction cast method for 55 days at which time a roentgenogram (Fig. 6) showed the fragments in good position and regional atrophy as marked in the

head as in the distal fragment. Callus formation was questionable. Because of coexisting chronic polyarthritis the treatment from this time onward was by rest in bed. Figure 7, 131 days after injury shows further regional atrophy uniformly distributed and upward displacement of the lower fragment with considerable erosion of fragment ends. A roentgenogram 8½ months after injury showed beginning bony union. Figure 8 shows bony union complete 14½ months after injury and Figure 9 the reconstructed neck and the partially reconstructed malposed head at the end of 2 years and 5 months. There is some irregularity of articular cortex and cartilage space at the top of the head which is probably the result of the degenerative arthritis attributable both to the coexisting disease and to the malposition following the fracture. Uniform atrophy of disuse is still present.

This case emphasizes the necessity for continued treatment in the presence of delayed union, in the hope bony callus may form late even after considerable erosion of the neck.

Occasionally degenerative arthritis develops many years after bony union of an intracapsular fracture with apparent survival of the head and a good functional result.

CASE 4. Figure 10 shows roentgenograms of the hip joint of a female, aged 72 who 10 years previously sustained an intracapsular fracture of the femoral neck which was treated by the abduction cast method for 4 months. There was complete return of function and freedom from pain for 8½ years. She then developed pain on walking which persisted and finally led to slight limitation of motion. Figure 10 left, taken 10 years after injury shows slight narrowing of the cartilage space and sclerosis of bone along the weight bearing portion of the joint. The symptoms progressed slowly. Figure 10 right the condition 2 years later. Cartilage space is lost and subchondral sclerosis is marked in both head and acetabulum in the weight bearing portion. Slight coxa valga and irregularity at the fracture line are still present as evidence of the old, healed fracture.

The reason for the arthritis is not clear. Keefner and Myers have called attention to degenerative arthritis in various joints following trauma. There exists the possibility that in this case the head suffered necrosis and was completely transformed without collapse but the very long period of freedom from symptoms following the fracture speaks against it.

INTRACAPSULAR FRACTURE OF THE NECK WITH SURVIVAL OF THE HEAD FOLLOWED BY NON UNION

If the head remains alive and the fracture fails to unite there is always gradual erosion

of the neck fragments which continues until the proximal portion of the neck is destroyed, leaving only the head in the acetabulum. In some cases a considerable amount of distal fragment of neck persists especially in its lower portion. Figure 11, Case 5, shows the marked erosive effect of the more dense inferior cortex of distal fragment on the proximal fragment when the hip is not immobilized. It is a roentgenogram of the upper end of the femur excised from a 90 year old woman who sustained a mesial neck fracture (untreated) 20 days before death from pneumonia. The posterior capsule of the neck was torn and it and the round ligament contained blood vessels ample to keep the head alive. The lower cortex of distal neck fragment which had severely eroded head showed extensive necrosis of bone cells.

Atrophy of disuse gradually develops and becomes marked. It is of equal intensity in both head and distal fragments. The head retains its form and the cartilage space of the joint is preserved.

Case 6 illustrates the gradual erosion of the neck and the extreme even reduction in density which eventually ensues.

CASE 6. A female, aged 53 years, fractured the neck of the left femur as shown in Figure 12. A Whitman abduction cast was applied for 76 days at the end of which time a roentgenogram (Fig. 13) showed marked regional atrophy uniformly distributed in both fragments and questionable callus formation. Motion was then allowed and the patient walked on crutches. Figure 14 shows the result 11 months after fracture. Neck fragments are eroded and there is extreme regional atrophy which is equally marked in pelvis head and distal fragment, indicating the survival of the head with non union of fracture.

If the non union is successfully treated by open operation, the atrophy of disuse gradually disappears with the resumption of use and a good functional result is obtained. This is illustrated by Case 7.

CASE 7. A female aged 45 years sustained an intracapsular fracture of the neck of the femur which was treated for 128 days by an abduction cast combined with extension. A roentgenogram Figure 15, then showed upward displacement and non-union of the fracture with marked but uniform regional atrophy affecting equally both head and distal fragment. The shadows of the fragments of the lower portion

of the neck overlap giving a dense appearance. The patient was then operated on by Dr. Donald C. Keyes, the fragments being reduced and fixed by an autogenous tibial graft. Figure 16 shows a bony union 10 weeks later but both head and distal fragment are still uniformly atrophied. Use of the limb was then resumed and the function gradually returned almost to normal, with freedom from pain. Figure 17 taken 23 months later shows a density restored to normal and equal in the two fragments with preservation of articular cortex and the normal width of cartilage space.

Bony union was obtained in another patient operated on similarly 10 months after fracture.

When there is non union and a living head operation with appropriate approximation and fixation of head to shaft offers good chances of bony union. The Brackett operation or its modification by Magnuson has given successful results. An autogenous bone graft, as employed in this case, is probably the best material to use for fixation although screws and nails, such as the one devised by Smith-Peterson, have also been used with variable degrees of success, and are more easily applied.

Cases of non union with living head that are left untreated for long periods usually show marked atrophy and upward displacement of the trochanter. After neck erosion is complete a cortex usually forms along the eroded surfaces and adhesions develop between these and the capsule which on examination at operation or autopsy may be found infolded. With fibrous fixation there may be a gradual increase in weight bearing power of the hip and the patient may be able to do a moderate amount of walking without crutch or cane. With usage the density of the bones gradually increases and new trabeculae may be laid down in the head as a result of pressure of distal fragment upon it in an abnormal direction. The cartilage space and the shadows of articular cortex are preserved in such cases. The late result is illustrated by Case 8.

CASE 8. A male, aged 68 years, suffered a fracture of the hip 13 years previous to examination. Non union with shortening of the limb resulted but he had been able to do a moderate amount of walking without crutch or cane for 10 years with but little

discomfort. A roentgenogram (Fig. 18) showed complete loss of neck with close approximation of head and intertrochanteric region and increased density indicating osteosclerosis along the eroded fracture surfaces. The density of the bones of the hip was slightly reduced but was equal in head and surrounding bone. Cartilage space of the joint was of normal width. The bony trabeculae of head and intertrochanteric region were irregularly arranged as a result of stresses acting on the fragments in malposition.

It has been found at operation that a living head in case of non union is usually free from adhesions over its articular surface. This probably accounted for the wide range of mobility in 2 such cases in this series in which bony union followed a bone pegging operation.

INTRACAPSULAR FRACTURE OF THE NECK WITH NECROSIS OF HEAD FOLLOWED BY NON-UNION

Necrosis of a part or all of the head follows fracture of the neck if the blood supply is too extensively cut off by the injury. Schmorl, Hesse, Nussbaum and Santos have described the pathological changes in several cases. Fourteen excised heads showing partial or complete necrosis have been examined pathologically in this series. They were removed from 2 months to 4½ years after the fracture occurred and showed not only different amounts of necrosis but also different degrees of organization of the necrotic portion. In 6 cases the necrosis appeared to have been total, in 3 cases partial, and in 5 cases the examination was made so long after injury and the transformative changes were so marked that it was impossible to determine whether the necrosis had been partial or complete.

In 15 additional cases the diagnosis of necrosis in the femoral head has been made from roentgenological examination only based on criteria established by the correlation of pathological and roentgenological findings in the other group.

If capsule of neck is completely torn there is much greater likelihood of necrosis than if it is partially intact. However complete necrosis may occur when much of the capsule is intact, as in Case 8 reported by Santos. Necrosis may occur in the presence of impaction of fragments as shown by the same case.

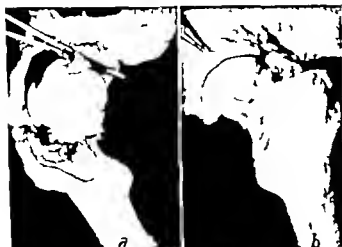


Fig. 1. Case 1. Five days after injury. a. Anterior view neck fractured and capsule torn. b. Posterior view capsule unruptured.

The early changes which occur in the necrotic area consist of disappearance of the cells of both the bone and the marrow. If a portion of the head remains alive it is likely to be near the fovea or in the inferior part where the blood supply is derived from round ligament or unruptured capsule. Atrophy of disuse gradually develops in the distal fragment, in acetabulum and in case of partial necrosis in the surviving portion of the head. The necrotic bone does not atrophy but retains its original



Fig. 2. Healed intracapsular fracture of neck with survival of head 5 years after injury. Equal degree of density of head and shaft.

density. Consequently after 2 to 4 months of disuse it casts a heavier shadow in roentgenograms than the surrounding atrophied living bone. The neck fragments are gradually eroded. The dead bone is gradually invaded by connective tissue which replaces the dead marrow. If the entire head is dead the invasion is by way of the round ligament and unruptured portions of the capsule in the earlier



Fig. 3. Case 2. Section of upper end of femur showing 15 day old intracapsular fracture of neck with survival of head. Fibrous callous in fragment ends. Death of cortex of distal fragment of neck beyond points a and b.



Fig. 4. Case 2. Photomicrograph showing fibrous marrow and eroded dead trabeculae along the surface of the fragment end a, bone and marrow of deeper portion alive b.



Fig 5

Fig 6

Fig 7

Fig 5 Case 1 Fresh transverse fracture of neck. Subsequent figures show survival of head and delayed union.

Fig 6 Case 1 Fifty-three days after receipt of injury. Atrophy was equally marked in both the frag-

ments, indicating the survival of the head. stages later it may be by way of adhesions. If a portion of the head remains alive connective tissue grows out from its margin and invades the dead bone.

Behind the zone of invasion comes a zone of transformation of the dead bone. The invading connective tissue of the marrow spaces is embryonal and differentiates into bone and bone marrow. Some of the old bone is absorbed

while some of it has new bone laid down on its surface and is gradually replaced by it through the process of creeping substitution. Wherever new bone is laid down new bone marrow containing both hematopoietic and fatty cells is also formed. The new bone is usually much more spongy than the old bone which it has replaced and defects are sometimes left filled with marrow which in the X-ray give a cystic

Fig 7 Case 1 Roentgenogram 151 days after injury. Delayed union, displacement of fragments, and some erosion of neck. Atrophy equal in the two fragments. Survival of head and delayed union of fracture.

Fig 8, left Case 1 Bony union 143½ months after injury. Atrophy still equal in the two fragments.



Fig 8, left Case 1 Bony union 143½ months after injury. Atrophy still equal in the two fragments.

Fig 9 Case 1 Reconstructed neck and newly formed trabeculae in weight-bearing portion of head and neck 1 year 5 months after injury.



Fig. 10. Case 4. Intracapsular fracture of neck with survival of head and bony union. Arthritic symptoms began 8½ years after injury. Left, roentgenogram after 10 years, right, after 13 years.

appearance. The rate of connective tissue invasion and creeping substitution of the dead bone is slow, requiring several months to years for completion depending largely on the extent of the necrotic area.

Articular cartilage very slowly dies when its underlying bone is necrotic as the great bulk of the nutrition comes from the bone. However some nutrition comes from the synovial fluid as shown by Nussbaum and cartilage cells are sometimes kept alive by it for long periods. If the underlying dead bone is rapidly absorbed and replaced by new bone the cartilage may be revived and persist. This was observed in animal experiments to be reported and in one human case 2 months after fracture. Pieces of cartilage chipped off by the fracture may remain free in the joint. Their surviving superficial cells may proliferate and after years form oval loose bodies nourished by the synovial fluid as was found at operation in 2 cases of this series. The nuclei of the dead cartilage on the head break down very slowly and those near the bony attachment sometimes may not completely disappear for 2 or 3 years. The dead cartilage

is usually slowly absorbed in the course of 3 or 4 years and replaced by a thin layer of fibrocartilage or fibrous tissue. Sometimes the opposing articular cartilages become adherent and are simultaneously absorbed narrowing the cartilage space of the joint. Articular cartilage overlying living portions of the head remains alive.



Fig. 11. Case 5. Erosion of deep hole in head by inferior cortex of lower fragment 20 days after intracapsular fracture in 90 year old woman.

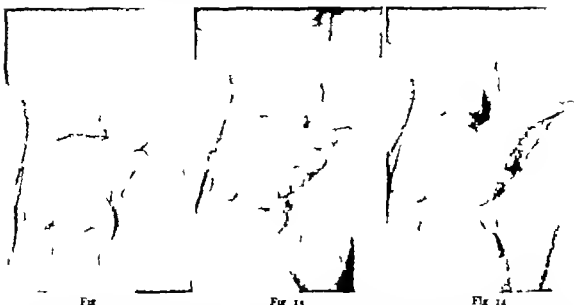


Fig. 12

Fig. 13

Fig. 14

Fig. 12 Case 6 Fresh intracapsular fracture of neck of femur. Female, aged 53 years.

Fig. 13 Case 6 Seventy-six days after fracture. Resorption atrophy is equally marked in both fragments,

indicating survival of the head, union is questionable.

Fig. 14 Case 6 Eleven months after fracture. Atrophy equally marked in both fragments. Neck eroded. Survival of head and non-union.

Case 9 illustrates partial necrosis of the bone and cartilage of the head with fibrous invasion and creeping replacement of the dead bone by new bone in the act of occurrence.

CASE 9. Female, aged 65 years, a teacher fractured the intracapsular portion of the neck of the left femur and was treated for 20 weeks by the Whitman abduction cast method. A roentgenogram 152 days after injury revealed non-union with some erosion and displacement of fragments (Fig. 19). The pelvic and distal fragment showed reduction in density. Most of the superior and lateral portions of the head were denser than the surrounding bone and the shadows of the trabeculae were as heavy as those of normal bone. The medial portion about the fovea and the inferior portion were greatly reduced in density. The diagnosis was made of non-union and extensive necrosis in femoral head. Because of the necessity for restoring the economic efficiency of the patient as rapidly as possible, an operation for unloading the hip was carried out. At operation the fracture was found ununited and the neck fragments extensively eroded. A portion of the capsule was intact posteriorly and the round ligament was intact. The head was excised, the cartilage of the acetabulum removed, the greater trochanter denuded and inserted into the acetabulum, and a whole thickness onlay tibial graft inserted. Bony union was present after cast immobilization for 12 weeks and walking was resumed after 5 months.

The neck portion of the proximal fragment was completely eroded. The articular cartilage was

smooth and intact except where destroyed by erosion at the upper margin. A coronal section 5 centimeter thick was cut through the middle of the head, passing through the fovea. There was an irregular area bordering on the fovea and the inferior portion of the head which was dark gray in color and contained fine, spongy bone. The lateral and superior portion was lighter in color and composed of dense bone. The subchondral portion at the top of the dense area was yellowish in color. A fibrous band could be seen along the irregular line of junction of the dense and porous portions. A roentgenogram (Fig. 20) of the slice confirms the difference in density between the inferomedial and the superolateral portions and shows the normal arrangement of the old trabeculae of the latter. Cortex above the fovea is of normal density while that below is irregularly reduced in density. A microscopic section of the slice (Fig. 21) confirms the size and arrangement of the trabeculae in the two regions. On high power examination it was found that the articular cartilage and the old, dense bone in the superior and lateral regions were dead and that cancellous spaces of the bone were occupied by fibrous marrow except at the top where the old dead marrow was still present (Fig. 22). Dead or microbiotic cartilage and dead bone with cancellous spaces filled with fibrous marrow are seen in Figure 23. The inferomedial portion showed living bone and hemopoietic marrow, the bony trabeculae being very small and irregularly arranged. The articular cartilage from the inferior margin of the fovea downward was alive except for a short stretch at the neck margin, and its bony cortex was



Fig 15

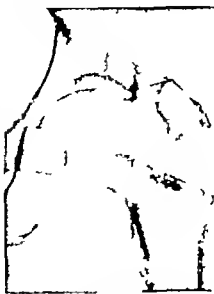


Fig 16



Fig 17

Fig 15. Case 7. Roentgenogram which was taken 128 days after the fracture occurred. Atrophy is equal in the head and in the shaft. There is non-union with survival of the head.

section of an autogenous bone peg. Atrophy is still equal in the two fragments.

Fig 17. Case 7. Twenty three months after operation. Bony union, density increased and uniform in both fragments. Cartilage space preserved. Living head and bony union.

Fig 16. Case 7. Roentgenogram 10 weeks after the in-

extremely thin and in places incomplete (Fig 24). This indicates survival of articular cartilage and some of bone of the inferior portion of the head due to preservation of its blood supply through round ligament and perhaps untorn capsule. The cells of the dead cartilage over the superior portion had largely disappeared. Creeping replacement of dead bone and fibrous marrow by living bone and hemopoietic marrow is seen along the entire junction of the dense with the rarefied bone (Fig 25).

phied living bone and how much is new bone that has replaced dead portions.

Complete necrosis of the head is well illustrated by Case 2 of the series reported by Santos. Sixteen months after injury there was non union of the fracture with erosion of the neck fragments. The head cast a uniformly dense shadow while the surrounding bone of pelvis and distal fragment showed marked reduction in density from atrophy of disuse (Fig 26). A section of the excised head (a)

Conclusions in this case from pathological examinations are that as a result of the injury all of the head except probably the regions of the fovea and the more superficial portions of the inferior part had blood supply cut off resulting in necrosis and non union. The living cartilage on the under side of the head changed but little. The bone which remained alive underwent atrophy. There was fibrous invasion of the marrow spaces of all of the dead bone except an oval area at the top of the head, and creeping replacement was well under way in the dead bone bordering on the old bone that remained alive. It is almost impossible to distinguish between atrophied old living bone and the new bone which has replaced the old dead bone except along the border where creeping replacement is actively going on. For this reason it is impossible to know how much of the live bone is old atro-



Fig 18. Case 8. Non union and survival of head 12 years after fracture. Atrophy uniform in the two fragments. Cartilage space of joint preserved.

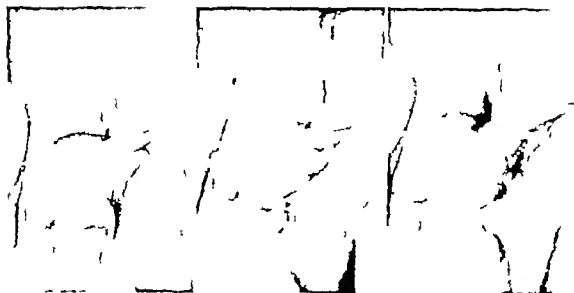


Fig. 12

Fig. 13

Fig. 14

Fig. 12 Case 6 Fresh intracapsular fracture of neck of femur. Female aged 53 years

Fig. 13 Case 6 Seventy-six days after fracture. Regional atrophy is equally marked in both fragments,

indicating survival of the head, union is questionable

Fig. 14 Case 6 Eleven months after fracture. Atrophy equally marked in both fragments. Neck eroded. Survival of head and non-union

Case 9 illustrates partial necrosis of the bone and cartilage of the head with fibrous invasion and creeping replacement of the dead bone by new bone in the act of occurrence.

CASE 9. Female aged 65 years, a teacher fractured the intracapsular portion of the neck of the left femur and was treated for 30 weeks by the Whitman abduction cast method. A roentgenogram 15 days after injury revealed non-union with some erosion and displacement of fragments (Fig. 19).

The pelvis and distal fragment showed reduction in density. Most of the superior and lateral portions of the head were denser than the surrounding bone and the shadows of the trabeculae were as heavy as those of normal bone. The medial portion about the fovea and the inferior portion were greatly reduced in density. The diagnosis was made of non-union and extensive necrosis in femoral head. Because of the necessity for restoring the economic efficiency of the patient as rapidly as possible, an operation for ankylosing the hip was carried out. At operation the fracture was found ununited and the neck fragments extensively eroded. A portion of the capsule was untorn posteriorly and the round ligament was intact. The head was excised, the cartilage of the acetabulum removed, the greater trochanter denuded and inserted into the acetabulum, and a whole thickness ooley tibial graft inserted. Bony union was present after cast immobilization for 15 weeks and walking was resumed after 5 months.

The neck portion of the proximal fragment was completely eroded. The articular cartilage was

smooth and intact except where destroyed by erosion

at the upper margin. A coronal section 5 centimeter thick was cut through the middle of the head, passing through the fovea. There was an irregular area bordering on the fovea and the inferior portion of the head which was dark gray in color and contained fine, spongy bone. The lateral and superior portion was lighter in color and composed of dense bone. The subcortical portion at the top of the dense area was yellowish in color. A fibrous band could be seen along the irregular line of junction of the dense and porous portions. A roentgenogram (Fig. 20) of the slice confirms the difference in density between the inferomedial and the superolateral portions and shows the normal arrangement of the old trabeculae of the latter. Cortex above the fovea is of normal density while that below is irregularly reduced in density. A microscopic section of the slice (Fig. 21) confirms the size and arrangement of the trabeculae in the two regions. On high power examination it was found that the articular cartilage and the old, dense bone in the superior and lateral regions were dead and that cancellous spaces of the bone were occupied by fibrous marrow except at the top where the old dead marrow was still present (Fig. 22). Dead or microblotic cartilage and dead bone with cancellous spaces filled with fibrous marrow are seen in Figure 23. The inferomedial portion showed living bone and hematopoietic marrow, the bony trabeculae being very small and irregularly arranged. The articular cartilage from the inferior margin of the fovea downward was alive except for a short stretch at the neck margin and its bony cortex was



Fig 22



Fig 23



Fig 24

Fig 22 Case 9 Dead bone, cartilage, and marrow at a in Figure 21

Fig 23 Case 9 Dead cartilage and bone with cancellous spaces filled with fibrous marrow at b in Figure 21

Fig 24 Case 9 Living cartilage and atrophied old living bone at c in Figure 21

weight on the limb. A series of roentgenograms showed gradual absorption of neck and upward displacement of shaft, with downward tilting of the nail. Atrophy of diaphysis increased in pelvis and shaft of femur. The head of the bone, however, remained dense except in the regions of the fovea and medially below the nail, where a gradually enlarging area of reduced density developed. Figure 28 shows the condition 13½ months after injury. A roentgenogram 1¾ years after injury showed further transformation with only about two-fifths of the old dense area remaining. The nail was then removed which lessened the discomfort on walking which the patient had experienced for more than a year.

A small amount of head supplied by blood through the ligamentum teres may have remained alive about the fovea and atrophied but the gradual enlargement of the area of reduced density was undoubtedly brought about by creeping substitution of the dead bone by spongy new bone. However, cases of necrosis in femoral head with non union of short duration in which neck erosion is absent or not marked may be operated on and bony union obtained followed by rapid creeping substitution of the dead bone by new bone. The head should be adequately protected from weight bearing during the period of transformation in order to avoid breaking down of the dead bone and deformity. A good result was obtained in

Case 14 (Fig 38) of this series although a small portion of the head was detached.

Case 11 shows the slow rate of transformation of the dead bone in long standing necrosis of the upper part of the head and the satisfactory result which was obtained after bony union obtained by the Brackett operation.

CASE 11. A female, aged 58 years fractured the neck of the femur 3 years before admission. She was treated originally by bed rest with weight extension for 3 months, after which she walked with crutches.



Fig 25. Case 9. Junction of dead and new living bone at d in Figure 21. Creeping substitution of dead bone and fibrous marrow e by spongy living bone and hematopoietic marrow f.



Fig. 26. Sixteen months after fracture. Non-union and complete death of head. Excised head, *a*, shows fibrous union medially. *b*, slight absorption and bony replacement of head. Light portion laterally uninvolved. Old dead trabeculae shown in roentgenogram of slice.

A roentgenogram on admission (Fig. 20) showed non-union of fracture and loss of femoral neck. Pelvis and shaft of femur showed great reduction in density. The density of the head of the femur was greatly reduced, except at the top where a cone-shaped area had the original density of the bone. Cartilage space of joint was normal in width and the

shadow of articular cortex of head was intact, although greatest over the dense area. A diagnosis was made of necrosis in the head of the femur the original extent of which could not be stated at this time but an island of which still persisted.

A Brackett type of operation was performed by Dr. C. Howard Hatcher which gave bony union after 10 weeks of plaster cast fixation. A useful movable and almost painless hip was obtained with 2 1/2 inches of shortening of the limb. Figure 30 shows the result 1 year later. Dense new bone formed across the fracture line and replaced old dense bone in the weight bearing portion of the head.

The case shows that after the dead bone has been largely replaced by living bone, an operation may result in union of the fracture and a useful limb.

In the course of a few years all of the dead bone may be replaced by new bone and the dead cartilage by fibrocartilage or fibrous tissue. The head then consists of spongy bone with a frail and irregular articular cortex. The cartilage space of the joint is usually narrowed. There may be cavity like areas in the head. These features may make possible the X-ray diagnosis of complete substitution of a partial or complete necrosis of the head as in the following instance.

CASE 12. Female aged 53 years sustained an intracapsular fracture of the neck of the femur which



Fig. 27, left. Case 10. Roentgenogram 66 days after injury. Nailing 5 days after injury. Slightly greater density of head suggests that it is necrotic.

Fig. 28. Case 10. Thirteen and one half months after injury. Non-union of fracture and necrotic head, reduced density in medial and inferior parts of head indicates creeping substitution of dead bone by new bone.

was treated by Whitman abduction cast for 2 months followed by bed rest for 12 weeks. A roentgenogram (Fig. 31) taken 11 months after injury showed non union erosion of neck fragments, and reduction in density of the hip bones except in the upper and lateral portions of the head, where the original bone density was preserved. The density of the lower part of the head was much reduced. The diagnosis was made of necrosis of the head of the femur with dead bone still retained in the dense regions. The large area of reduced density in mesial and lower portions of head suggest that some bone survived at least about the fovea. How much of the area of decreased density is occupied by atrophic surviving bone and how much by newly formed bone that has replaced old dead bone it is difficult to say. A roentgenogram (Fig. 32) taken 2 years and 11 months after injury showed complete disappearance of the dense shadows indicative of old dead bone with replacement by a faint spongy shadow. The articular cortex casts a faint irregular shadow and cartilage space is somewhat narrow. The irregularity of cortical shadow in the narrow cartilage space suggests death and re-organization of the entire articular cartilage. The diagnosis was made of a fracture of the neck of the femur followed by non union death of the head, and complete creeping substitution of the dead bone by living bone.

A Whitman reconstruction operation was performed. During excision of the head extensive adhesions were encountered between the articular surfaces. Round ligament was buried in adhesions. The articular surface of the excised head was uneven and shaggy from adhesions. On cut section, the head consisted of spongy bone throughout, no areas being seen suggestive of remnants of necrotic tissue. Microscopic examination (Fig. 33) showed the bone to be

alive and finely porous with trabeculae irregularly arrayed. Articular cartilage was everywhere replaced by fibrocartilage, which at a number of places was very narrow while in others it was as thick as normal articular cartilage. The articular cortex was very frail and in some places entirely lacking.

The rate of transformation in this case was more rapid than in some others of the series. One case 3 years and 8 months after injury and another 4 years after injury showed more than half of the necrotic bone still present on pathological examination of the excised heads. These two cases also showed osteocartilaginous loose bodies formed by proliferation of detached pieces of articular cartilage which were nourished by the synovial fluid. In some cases of non union of long standing it may be impossible to state from roentgenograms whether the bone of the head survived and became atrophic or died and underwent complete replacement by new bone but the differences previously enumerated usually make it possible. Pathological examination of the head should nearly always establish the diagnosis.

Cases with non union and necrosis of the head of very long standing and marked cartilage change are not well suited for operation intended to create bony union and a movable joint. The Whitman reconstruction operation may be followed by a bony ankylosis as in one



Fig. 29, left Case 11 Non-union 3 years after fracture. Necrosis in head with creeping replacement by spongy new bone except dense island at top of head a

Fig. 30 Case 11 Bony union and dense transformation of weight bearing portion of head and shaft 13 1/2 years after operation



Fig. 3. Left. Case 12. Non-union 11 months after fracture. Superior and part of lateral portions of head dense, indicating old dead bone. Inferior and foread regions rarefied, indicating living bone.

Fig. 5. Case 2. Two years 11 months after injury. Creeping substitution of dead portion by living bone complete. Cartilage space of joint narrowed and shadow of articular cortex incomplete.

case of the series reported elsewhere by the author (18) in which articular cartilage of acetabulum was destroyed. Operation for the creation of bony ankylosis is the procedure of choice for some of these cases.

INTRACAPSULAR FRACTURE OF THE NECK WITH DEATH OF THE HEAD FOLLOWED BY BONY UNION

Axhausen (2) was the first to call attention to this condition and his is the only reported case in which a pathological examination was made. Familiarity with the pathological and roentgenological pictures in necrosis of the femoral head and non union makes it possible to recognize the not infrequent occurrence of necrosis of the head with bony union by the study of a series of roentgenograms taken at regular intervals. There were 4 instances in this group of 49 cases of fracture of the neck of the femur. Necrosis of the femoral head followed by bony union of the fracture has been observed most frequently in case of impaction of the fragments. But also in cases in which fragments were displaced it has fol-

lowed reduction of the fracture and fixation by the Whitman abduction cast method (Case 11 of Santos) or by bone pegs or nails.

Union of the fracture is accomplished by callus formation from the distal fragment which extends across the fracture line and ossifies in much the same way as a bone graft unites with bone with which it is placed in contact. If the limb is then used the distal fragment and pelvis do not atrophy to the same extent as in cases of non union. Consequently the density difference between the dead portion of the head and the living bone of the region is not as marked as in cases of necrosis with non union and the condition is more difficult to recognize on this basis in roentgenograms than is the former. If there is too much weight bearing before the necrotic upper portion of the head is invaded and substituted by new bone there will be caving in of the weight bearing portion with marked deformity. This is illustrated by Case 13.

CASE 13. Male, aged 48 years, patient of Dr. Paul P. Swett of Hartford, Connecticut, sustained an intracapsular fracture of the neck of the femur

which was treated by plaster cast immobilization. Bony union followed, and he was then allowed to walk. The hip gradually became painful and a roentgenogram (Fig 34) taken one year after injury showed slight irregularity of cortex flattening and subcortical increased density at the top of the head. There was irregular, increased density across the mesial portion of the neck at the seat of fracture, and slight, even reduction in density in the juxtafoveal and lateral portions of the head. The density of the central and superomesial part of the head was slightly greater than that of the distal fragment. Weight bearing was continued but the hip became increasingly painful and limited in motion. A roentgenogram (Fig 35) 13½ years after injury showed further collapse of the weight bearing portion with mottled increased and decreased density in the head beneath it. New trabeculae were seen running perpendicularly in head and neck. There was considerable atrophy of diaphysis. A regional roentgenogram (Fig 36) 6 months later showed a slight increase in density of the region and reduction in size of the area of the sequestered head. The rest of the head appeared to be transformed. Judging by the slowness of the changes 2 or 3 years will be required for complete absorption and reorganization of the collapsed area, and the end-result will be a marked degree of functional disturbance in the joint.

A re-examination of the 5 year old Case 11 reported by Santos of bony union with necrosis and collapse of the head, was made 9 years after injury. Pain and weakness had grown progressively worse and the patient had walked with a crutch for 2 years. A roentgenogram showed that the collapse and deformity of the head had slightly increased and its interior become more mottled. Two other cases of collapse of the head observed for periods of 4 to 9 years gave very poor functional results.

That a good functional result may be obtained after fracture of the neck with necrosis of the head and bony union, if collapse does not occur and creeping substitution comes about is shown by the following instance:

CASE 14. Female, aged 13 years, sustained an intracapsular fracture of the neck of the femur. A body and leg cast was applied for 6 weeks. Two months after injury a roentgenogram showed displacement and angulation of fragments, and non-union. At operation, which showed a portion of capsule un torn, the fracture was reduced and fixed with a Smith Peterson nail plaster-of paris immobilization for 10 weeks. Bony union took place but weight bearing was not resumed until 5 months had elapsed. During this period a series of roentgenograms showed the gradual development of



Fig 33. Case 12. Magnification 55 diameters. Shows complete replacement of dead cartilage by fibrocartilage and dead bone by spongy new bone.

areas of reduced density progressing from neck into head, indicative of creeping substitution of a necrotic proximal fragment. Six months after injury the patient walked without pain and had three fourths the normal range of motion in the joint. A roentgenogram (Fig 37) showed mottling of the largely transformed head and neck. At the summit of the head the articular cortex was dense and smooth, and showed signs of incomplete sequestration at its limits. Weight bearing was continued without discomfort, and the range of motion increased gradually. Sixteen months after injury it was four fifths normal and the joint was free from symptoms. A roentgenogram (Fig 38) then showed a complete reconstruction of the head except at the summit, where there was a narrow dense area including articular cortex, indicative of dead bone, which was sequestered and slightly depressed.

It would have been better to have kept the patient from weight bearing for a longer period than 5 months, since the small dead area at the summit of head was broken down before creeping replacement had had time to reach it. However the area was so small and the rest of the head was so well trans-

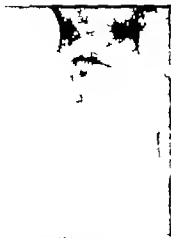


Fig. 34



Fig. 35



Fig. 36

Fig. 34. Case 3. Necrotic head and bony union 1 year after intracapsular fracture of neck. Note beginning breaking down of a right bearing portion of head with dense underlying bone.

Fig. 35. Case 3. One and one half years after injury. The roentgenogram shows further collapse of the right

bearing portion and irregular absorption and sclerosis of head.

Fig. 36. Case 3. Twenty-six months after injury. Collapsed portion dense and sequestered rest of head transformed. Sclerosis of zone is noticeable about collapsed portion.

formed that the defect should be repaired without loss of the excellent function that has already been obtained.

Experience with these cases has demonstrated that walking should not be allowed in case of necrosis of the head with bony union until many months have elapsed in order to avoid fragmentation and collapse of the necrotic bone at the point of greatest pressure. No doubt too early walking has been responsible for the bad end results in many cases. However it is probable that despite weight bearing the dead bone does not collapse in some cases and becomes completely replaced by new bone giving a good functional result. Such cases may be difficult to distinguish late from others in which there was union of the fractured neck with survival of the head. The mottling of the transformed dead head should however be sufficiently great in most cases to render its recognition possible in roentgenograms. Case 4 illustrates the difficulty in differentiation.

SLIPPING OF THE EPAPHYSIS OF THE HEAD OF THE FEMUR

The capital epiphysis of the femur not infrequently becomes separated and downwardly displaced on the neck. The condition

is seen more frequently in boys than in girls and usually develops between the ages of 10 and 16. There is a definite predisposition on the part of obese individuals and an endocrine disturbance has often been held responsible for it. It is encountered in some cases presenting Froelich's syndrome. There is often roentgenographic evidence of reduced density in the metaphysis of the neck before the slipping takes place and shortly after the onset of pain in the hip. Slight flattening of the head has also been observed before any appreciable amount of displacement is brought about. Arthausen considers these changes secondary to aseptic necrosis in the neck metaphysis from obscure vascular blockage.

Slipping of the capital epiphysis has rarely been noted before the age of 10, and in such cases necrosis with breaking down of femoral head is likely to take place. Thus, a case was observed in which there was Legg Perthes disease of the right hip beginning at the age of 6 followed by slight flattening of the head of the left femur as shown incidentally in a roentgenogram taken 16 months later. Five days later the capital epiphysis of the left femur slipped markedly as a result of slight violence. After reduction and plaster cast fixation it united to neck, but necrosis and collapse of the head fol-



Fig. 37 left Case 14. Six months after operation. Mottled increase and decrease in density of proximal fragment and beginning sequestration of dense summit at a indicate necrosis and partial creeping replacement.

Fig. 38. Case 14. Sixteen months after operation. Creeping substitution complete except for sequestrum, a. Good functional result.

lowed with the typical roentgen appearance of Legg Perthes' disease on that side. This suggests strongly an etiological relationship between the two conditions.

In some cases the joint becomes painful without a history of trauma, but in the majority of cases the slipping is due to violence

of variable intensity often slight. Union nearly always takes place between head and neck even when the epiphysis is allowed to remain in marked displacement which results in growth arrest and coxa vara.

The changes in the head subsequent to slipping are variable. Slight to moderate flatten



Fig. 39 left Case 15. Roentgenogram immediately after slipping of capital epiphysis.

Fig. 40. Case 15. Roentgenogram 89 days after open reduction and fixation with fibular graft.



Fig. 41 Case 5 Nine years after injury Dense area at summit of left head indicates untransformed and possibly compressed necrotic bone rest of head collapsed and substituted by new bone Slipped epiphysis, right united and shows no collapse or other signs of previous necrosis

ing and broadening is common and the density may be uniformly reduced Mottling is rarely seen in roentgenograms The exact pathology of the head in such cases is not well known because of the extreme infrequency of reports of pathological examinations It is possible that necrosis precedes slipping but more probable that the head usually remains alive on nourishment coming through the round ligament and changes its contour after displacement In some cases however there is definite evidence of extensive necrosis and the weight bearing portion of the head may subsequently collapse and be sequestered as in fracture of the neck with bony union and

too early weight bearing In such cases the slipping damages blood supply by way of capsule vessels

CASE 15 A tall slender male aged 16 years, fell from a bicycle and displaced the right femoral epiphysis one year previously He was treated by plaster cast immobilization Bony union followed with the head in moderate downward displacement On the day of hospital admission he again fell from a bicycle and displaced the left capital epiphysis (Fig. 39) One day later the displacement was reduced by open operation and the head fixed in position by a bone peg taken from the shaft of the fibula The neck capsule was found extensively torn Cast immobilization A roentgenogram (Fig. 40) 89 days later showed bony union in convex position Walking was then resumed, but the left hip subsequently remained much stiffer than the right and was slightly painful and weak on excessive usage Figure 41 shows the condition of hips 9 years after injury to the left and 10 years after injury to the right The left hip shows flattening of head and irregularity of articular surface of both head and acetabulum There is a dense irregular shadow at the summit of the head which is difficult of interpretation It might be a necrotic area or a sclerotic transformed zone as it is very dense for old necrotic bone and shows no line of separation from the surrounding spongy bone If it is dead bone, the period of creeping replacement has been unusually slow If it is sequestered there has been marked retardation of the process of removal of the dead bone The narrow cartilage space of the joint indicates destruction of articular cartilage



Fig. 42

Fig. 42 Case 16 Three years after fracture of base of neck Head broken down in weight bearing portion and outline of cortex irregular and distorted neck mottled and dense changes indicate necrosis with creeping replacement

Fig. 43 Case 17 Female aged 12, recent fracture of greater trochanter



Fig. 43



Fig. 44

Fig. 44 Case 7 Six and one-half years after injury Dense area at summit of head indicates necrotic bone collapse of top of head and irregular creeping substitution of remaining portions top of neck irregular, necrosis apparently due to injury of superior neck vessel at time of fracture

The bad end result must be attributed to necrosis of the head with collapse before there was creeping replacement by new bone. The operative reduction and fixation were probably factors in producing the necrosis. Much better anatomical and functional results were obtained in the right hip which shows healing with moderate coxa vara. That head does not appear to have undergone necrosis and the cartilage space of the joint is preserved.

FRACTURE OF THE BASE OF THE NECK OF THE FEMUR

It has been generally considered that fractures at the base of the neck of the femur do not interfere with the blood supply of the head and neck. Roentgenological studies have shown, however, that necrosis may occur, although rarely. Lange (11) has reported 2 cases and there was one instance in this group.

CASE 16. Female, aged 17 years, sustained a fracture at the base of the neck 2 years and 5 months before admission. She was treated by extension for 5 weeks and a plaster cast for 4 weeks. Bony union resulted with head and neck at a right angle to the shaft. Walking was resumed, but the hip gradually became painful and motion was limited. A roentgenogram at the time of admission (Fig. 42) showed the head and neck united to the shaft at an angle of

90 degrees. The head was broken down and irregular in its weight bearing portion as if necrosis followed by creeping substitution had taken place. A subtrochanteric osteotomy was performed and union obtained with the shaft in abduction.

In case of fracture at the base of the neck with displacement and tearing of the capsule it is possible that the posterior cervical vessels may be torn and in case the collateral circulation through the round ligament is insufficient partial necrosis would be the inevitable result.

NECROSIS OF FEMORAL HEAD FOLLOWING FRACTURE OF THE GREATER TROCHANTER

The observation of roentgenographic signs of necrosis of the femoral head after fracture of the greater trochanter in the following case has raised the question as to the etiological relationship.

CASE 17. Female, aged 12 years, a patient of Dr. E. L. Mason of Eau Claire, Wisconsin, sustained a fracture of the greater trochanter of the left femur in an automobile accident (Fig. 43). The fracture healed and the patient was free from symptoms for 4 years. She then began to have limitation of motion and pain in the hip joint on walking which slowly increased.

A roentgenogram (Fig. 44) taken 6½ years after injury showed evidence of extensive degenerative and absorptive changes in the head of the femur. There was irregular flattening of the lateral half of



Fig. 45



Fig. 46



Fig. 47

Fig. 45. Case 15. Fresh fracture of acetabulum and dislocation of hip.

Fig. 46. Case 18. Eleven months after injury. Dense area represents necrosis at summit of head. *a*

Fig. 47. Case 18. This roentgenogram was taken 10 months after injury and shows creeping replacement of the dense necrotic area by blotchy new bone with little collapse of head.



FIG. 49, left. Necrosis of head and part of neck 3 months after arthroplasty. The head retains its old density and surrounding living bone is atrophied.

FIG. 40. Two years 8 months after Figure 48. Necrotic head partly eroded and partly substituted by ingrowth from neck. Joint space irregular and narrow.

the top of the head with mottled areas of reduced and increased densities in the underlying portion down to the neck. At the summit of the head was a uniformly dense area with a smooth articular cortex and irregular outlines similar to that seen in Figure 41. The density of the head mesial and inferior to this, was greatly reduced and more uniform in outline. There was a slight irregularity of trabeculae in the top of the neck and one area of reduced density suggesting a cavity. The acetabulum showed no change except for a slight flipping at its superior margin.

The diagnosis was made of aseptic necrosis with breaking down and partial substitution of the head of the femur. The only known factor to which it could be attributed was the fracture of the greater trochanter. The superior neck vessel supplying a portion of neck and head might easily have been injured and an inadequate collateral circulation would have resulted in death of the region which it supplied. The late appearance of symptoms is somewhat against this explanation. However the very slow rate of change sometimes observed in the necrotic head after fracture of the neck as shown in Figure 26 16 months after injury, or Figure 41 9 years after injury, would favor the view that the fracture of the trochanter injuring the blood supply was the cause of the necrosis in this patient. A walking calliper splint was applied which considerably reduced the amount of pain, but a roentgenogram taken 1 year later showed only slight increase in the reconstruction of the head.

No case of injury of this type followed by necrosis could be found in a search of the literature.

TRAUMATIC DISLOCATION OF THE HIP FOLLOWED BY NECROSIS OF THE HEAD OF THE FEMUR

In traumatic dislocation of the hip the ligamentum teres is always torn. In case the vessels passing through it are of importance for the blood supply of the femoral head, necrosis of bone would be expected unless the collateral circulation from the neck vessels is sufficient to keep it alive. In the past almost no consideration has been given to this possibility.

Chandler and Krcuscher recently reported a case of necrosis in the head of the femur following fracture of the acetabulum with dislocation of the hip. Stewart reported the same condition following a simple posterior dislocation of the hip from this department.

Four instances of necrosis of the head of the femur following dislocation of the hip have been observed in these studies, three following simple dislocation and one following fracture through the acetabulum with dislocation. Judging from these observations, the condition is of importance in the causation of poor end results in traumatic dislocation. In 2 cases, 1 reported by Stewart, the head gradually collapsed in its weight bearing portion. In an 11 year old boy, a patient of Dr. Frank Dickson, the head flattened moderately and showed mottled areas of increased and de-

creased density somewhat similar to Legg Perthes' disease. In the following case the dead part of the head became transformed with only slight flattening

CASE 18 Female, aged 14, patient of Dr Otto T Roberg sustained a fracture of the acetabulum with posterior dislocation of the hip as seen in a roentgenogram (Fig 45) taken immediately afterward. The dislocation was reduced and the hip treated by plaster of paris immobilization and extension for 6 weeks. Roentgenograms showed signs of healing of the fracture, and the head within acetabulum showed no changes in contour or density. Walking was allowed after 4 months. Slight stiffness and pain persisted in the hip and a roentgenogram taken 11 months after the injury showed a dense oval shadow occupying the summit of the head of the femur with irregular reduction in density suggesting cavities in the head, below and about the dense area (Fig 46). The shadows of articular cortex, both medial and lateral to it, were irregular and reduced in density.

A diagnosis was made of necrosis of most of the head of the femur from injury of blood supply by way of the round ligament, with persistence of a dense area of necrosis at the summit and irregular creeping replacement of the deeper necrotic portions with very slight flattening of the head.

Subsequent roentgenograms showed gradual reduction in size of the necrotic portion, and one taken 19 months after injury (Fig 47) showed almost complete disappearance of the dense shadow indicative of dead bone with little change of contour of femoral head and a motley shadow in the subcortical region, especially of the weight bearing portion. There was a lateral marginal lippling of the head. The functional result 2½ years after injury was good.

The case shows the importance of avoiding collapse while creeping substitution of dead by living bone is going on. Despite the fact that the creeping substitution without collapse occurred here in the presence of weight bearing it is a safer procedure during the transformative period to keep the patient on crutches or at least in a weight bearing caliper splint.

A study of the end results of a large series of traumatic dislocations of the hip is greatly needed in order to learn the frequency of necrosis of the femoral head and the extent of disability which it produces.

CONGENITAL DISLOCATION OF HIP

Collapse of the head of the femur and absorptive and proliferative changes similar to Legg Perthes' disease are well known follow-

ing either manipulative or operative reduction of congenital dislocation of the hip, as reported by Legg and Allison. The condition is most frequently attributed to injury of the blood supply coming through the round ligament. It may result either from compression of the elongated round ligament between the reduced head and acetabulum or, in some instances from tearing. Excision of the round ligament as has sometimes been practiced in open reduction should increase the incidence of necrosis of the head and should be avoided.

Pathological dislocation of the hip complicating acute pyogenic arthritis with effusion is a not uncommon occurrence and leads to severance of the round ligament. In some cases the head becomes necrotic in which event it may be difficult to distinguish the changes resulting from cutting off of circulation from those resulting from the infection.

A boy aged 7 years, had osteomyelitis of the proximal end of the shaft of the femur with suppurative arthritis and dislocation of the hip which was reduced by open operation, at which time the round ligament was found severed. Subsequent roentgenograms showed a dense head indicating necrosis which was followed by partial breaking down and almost complete ankylosis of the hip.

A second case shows that it does not always happen.

A male, aged 9 years, with acute hematogenous arthritis of the hip complicating staphylococcus osteomyelitis of astragalus the hip joint became dislocated. It was reduced. Subsequent roentgenograms, the last being 14 years afterward, showed no evidence of capital necrosis, and function was restored to normal.

NECROSIS OF FEMORAL HEAD FOLLOWING ARTHROPLASTY FOR ANKYLOSIS OF HIP

In the operation of mobilization of an ankylosed hip not only is the bony connection between head and acetabulum severed, but also the capsule of the neck is usually stripped in the delivery of head and neck. This may interfere with the blood supply sufficiently to cause necrosis of a part or all of the head, in which event the result of the operation is usually a poor one. The hip may remain painful and its range of motion be limited. Marked regional atrophy of disuse may develop in the pelvis and shaft of the femur, while the dead

bone does not atrophy. As a result, the necrotic portion may be distinguished in roentgenograms after a few weeks because it casts a heavier shadow than the surrounding living bone. The dead portion is gradually eroded from the joint side, reducing it in volume. It is also invaded from the neck side by connective tissue which brings about absorption and more or less complete creeping replacement by new bone. The erosion may proceed more rapidly than the creeping replacement when the head may be greatly reduced in size.

Two cases of capital necrosis following arthroplasty have been observed in this study. In one case previously reported the entire head became necrotic as shown in Figure 48, 5 months after operation. Roentgenograms made since the report and 2 years and 8 months after operation (Fig. 49) show the head reduced in size and density. The hip continued painful and motion was very limited.

In a second case a female aged 34 years, had primary healing of the operative wound but the upper portion of the head became necrotic and was gradually destroyed by erosion there being very little creeping replacement. Two years and 8 months later the head was reduced to about one fourth its original size and although the hip was freely movable it tolerated weight bearing poorly.

CIRCULATORY DISTURBANCES OF MORE OBSCURE NATURE

A discussion of necrosis in the head of the femur from known traumatic causes would be incomplete without at least a brief consideration of Legg-Perthes disease, death with collapse and separation, partial or complete of a portion of the head in adults and osteochondritis dissecans.

In Legg-Perthes disease the lesion is essentially a necrosis, which is usually confined to the head of the femur but not infrequently there are changes of an absorptive nature in the lateral portion of the metaphysis of the neck which suggest that they are also preceded by necrosis in that region. The necrosis in the head is followed by bone absorption and flattening. In some cases a portion of the dead bone may be sequestered by fragmentation of the trabeculae at the line of function

with ingrowing new bone. In other cases the dead bone seems to be compressed and casts a shadow in roentgenograms that is heavier than normal bone. Regeneration of the bone of the head comes about by vascular and fibrous invasion of the necrotic area with new bone formation and replacement partly after complete absorption and partly by creeping substitution. An exuberant fibroblastic reaction with excessive absorption of dead bone is sometimes seen which is in excess of anything seen in aseptic necrosis caused by fractures, and raises the question of whether some additional factor as infection is not active.

The necrosis is the result of a disturbance in the circulation but the cause of the circulatory disturbance is as yet imperfectly understood. It has been considered as due to injury to the blood vessels without associated fracture or dislocation of the hip. In many cases there is much in favor of this view as the lesion follows weeks or months after a trauma of considerable magnitude. The late appearance of symptoms in some cases might be understandable in view of the lateness of symptoms in cases of necrosis following hip dislocation and fracture. When the head only is necrotic, the injury might be of the round ligament. In case of changes in the head accompanied by extensive absorption in the superior and mesial portion of the neck, it is difficult to explain the condition on the basis of a trauma to the blood vessels. Disturbance of the superior neck artery might in some cases result in necrosis and absorption in both the head and the superior portion of the neck, but this would scarcely result from trauma without fracture. Also there are many cases in which there is no history of trauma and the condition is frequently bilateral, which is also a point against a purely traumatic etiology.

Disease involving and obstructing the blood vessel has been considered as a cause. Axhausen has considered the possibility of embolism. However this theory is not well supported on anatomical grounds. Arteritis such as occurs in rheumatic fever with obliteration of the vessel as described by Von Glahn and Pappenheimer has been considered as a possible cause by Phemister. Brunschwig and Day. *Streptococcus viridans* has grown in cul-

tures of biopsies in a few instances, but in the great majority of cases cultures of biopsies have remained sterile and it seems very improbable that bacterial action is the primary cause, at least in the great majority of cases. Seeding of bacteria in the field after occurrence of the necrosis may possibly explain some of the positive bacterial findings. Further studies will be necessary to clarify the nature of the disease.

Large areas of aseptic necrosis have been observed in the head of the femur in adults in which no adequate cause could be elicited. Freund reported the autopsy findings in the case of a 77 year old woman who had been bedridden for 2 years with lame hips. In the right hip there was a large area of necrosis with collapse at the top of the femur and in the left hip a similar collapsed area in the mesial portion of head extending outward from the fovea. In some areas there was separation of the dead bone from the living resulting from fragmentation of trabeculae. In others there was fibrous invasion and creeping substitution of the dead bone. The overlying articular cartilage was necrotic, folded and partly absorbed. Injury or embolism of the right superior neck vessel and of the left ligamentum teres artery might have produced the lesions. Schmorl (20) and Kraft have published accounts of similar lesions and Chandler reported a case studied pathologically of extensive aseptic necrosis with sequestration extending lateral and superior to the fovea capitis which he considered due to embolism. Weight bearing has usually caused a certain amount of collapse or sequestration in these cases with resultant pain, stiffness and permanent disability of the joint.

A few instances as those of Lange (10) of osteochondritis dessicans of the femoral head are recorded in which a portion of bone and articular cartilage has become necrotic and detached as loose bodies in the hip joint. The etiology is obscure but possibly it is the same as that of the larger areas of aseptic necrosis in adults that do not become detached and dislodged from their beds.

SUMMARY

Intracapsular fracture of the neck of the femur may by injury of blood supply result

in aseptic necrosis of a part or all of the head of the femur. This occurrence greatly increases the likelihood of non union of the fracture as shown by the statistics herein reported. Articular cartilage very slowly dies if the bone to which it is attached becomes necrotic. In case of non union, atrophy of disuse of the living bone develops during the period of immobilization while the dead bone of the head does not atrophy. Consequently after 2 to 3 months, it can usually be diagnosed in roentgenograms because its density is greater than that of the surrounding living bone. Connective tissue and blood vessels slowly invade the dead bone which in turn is absorbed and replaced by new bone by the process of creeping substitution. Months or years may be required for completion of the change. Necrotic cartilage is absorbed after a long interval and replaced by either fibrocartilage or connective tissue.

In case of necrosis in the head of the femur and bony union of the fracture, the necrotic area also becomes replaced by new bone if the dead bone is protected from too great weight bearing during the period of transformation. If it is used too much in weight bearing, the upper portion of head may collapse from the giving way of the dead bony trabeculae and a bad deformity and functional result be obtained.

Intracapsular fracture of the neck with survival of the head and either union or non union of the fracture may be diagnosed in roentgenograms by the uniformity of reduction in density in pelvis, head and distal fragment at all stages in the course of the injury. Bony union is followed by a good functional result, but late degenerative arthritis occasionally develops. Non union is more amenable to operative treatment if the head remains alive than if it becomes necrotic.

Slipped femoral epiphyses during adolescence or late childhood may result in aseptic necrosis followed by collapse and extensive deformity of the head as a result presumably of injury to blood vessels entering it by way of the neck.

One case each is reported of necrosis and collapse of the head of the femur following fracture of the base of the neck with bony union and fracture of the greater trochanter.

Traumatic dislocation of the hip always severs the round ligament which in some cases contains blood vessels supplying a portion of the head of the femur. Aseptic necrosis of this area results unless there is adequate collateral circulation from the neck vessels. Four such cases have been observed. Creeping substitution of the dead bone by new bone ensues. Too extensive weight bearing before the transformation is complete may result in collapse of the head and permanent lameness of the hip.

Congenital dislocations of the hip that are reduced by manipulation or operation and pathological dislocations of the hip may show signs of necrosis and breaking down of the femoral head due to damage of circulation by way of the round ligament.

Arthroplasty for the mobilization of ankylosed hips resulted in aseptic necrosis of the head of the femur in 2 cases with poor functional results.

Aseptic necrosis in the head of the femur of obscure origin is seen in Perthes disease in osteochondritis dissecans and in adults in which there is no history of an etiological factor. The essential change appears to be an interference with circulation. Causative factors that have been considered are trauma, embolism, obliterative vascular disease with or without an associated mild infection and constitutional and endocrine disturbances, but no single factor offers an adequate explanation for the picture.

The bearing of aseptic necrosis on the treatment of fractures of the neck of the femur and hip dislocations is discussed.

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TUMORS OF THE TENDON SHEATHS

THEIR CLOSE BIOLOGICAL RELATIONSHIP TO TUMORS OF THE JOINTS AND BURSE

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UPON an occasion such as this, it seems but fitting to present a study of some phase of tendon surgery. Dr. Allen Kanavel and his pupils have so well and so completely covered the infections in their relationship to later functional use that there is very little left to add to this subject. The tumors of the tendon sheaths, aside from the xanthomatic giant cell tumors so well described by Mason and Woolston of Kanavel's clinic in 1927 offer a more fertile field for investigation. The cases which have been reported in the literature although quite numerous offer such a diversity of pathological types that it is with considerable trepidation that a surgeon rushes in where pathologists fear to tread. Reports on tendon sheath tumors may in fact be said to be in exactly the same position as the tumors of bone were 15 years ago. Descriptive adjectives regarding the types of cells noted in these tumors have been used to set up clinical entities. If consideration were given to the biological origin of these tumors and the descriptive adjectives reserved for definition of the characteristics of the tumor a real advance might be made in getting a more uniform nomenclature. With such a point of view the writer after reviewing the material from the University of Rochester clinic, hesitatingly offers a tentative classification. A study of the tumors of joints and bursae should be included to make this classification complete. This paper will be limited however to the tumors of the tendon sheaths. The tumors of the joints and bursae will be reported in a later publication.

CASE 1. A. J. No. 203 a woman 40 years of age, came into the surgical clinic on August 22, 1931 for the removal of a small tumor on the right thumb. There was a growth the size of a pea present on the extensor tendon of the thumb near the interphalangeal joint. It did not cause any pain and removal was for cosmetic reasons only. Under local anesthesia the tumor was dissected free from the extensor tendon sheath where the sheath expanded into the

capsule of the interphalangeal joint. Macroscopic examination showed a hard nodule of yellowish tissue 4 millimeters in diameter. There was a thin fibrous capsule about it. Microscopically there was a diffuse infiltration of large mononuclear cells and giant cells into the fibrous tissue which comprised the bulk of the section. The giant cells had centrally arranged round oval, or angle shaped nuclei. In many areas there were brown pigmented granules—some of which were phagocytized by round cells (Fig. 1). Diagnosis: giant cell fibroma of tendon sheaths. There had been no return of the growth on examination 2 years later.

CASE 2. J. B. No. 33164 a man 65 years of age was seen on August 21, 1930 in the surgical out patient department because of a tumor on the flexor surface of the left ring finger. This tumor was firm about 1 centimeter in diameter and showed some evidence of inflammation possibly a low grade infection. It was removed under local anesthesia, but all of it could not be excised because it involved periosteum as well as flexor tendon sheath. Microscopic section showed dense fibrous tissue with many giant cells. The nuclei were scattered all through these giant cells and were not confined to periphery (Fig. 2). Diagnosis: giant cell fibroma. The wound became infected and it was almost 1 month before healing occurred. The patient has not reported to the hospital since October 1930. At that time the wound had healed without evidence of recurrence.

CASE 3. A. S. No. 6629 a woman aged 63 years was admitted to the surgical out patient department on April 13, 1927. She had noticed a swelling on the dorsum of the terminal phalanx of the left middle finger for about 2 years. Six months ago a second similar lesion appeared more proximal to the original growth. There has been no pain or tenderness associated with these swellings. On examination, there was found a rounded swelling 1 centimeter in diameter on the radial side of the distal phalanx of the middle finger of the left hand. This swelling was firm not attached to the bone, and did not fluctuate. The skin over it was movable but it seemed anchored to the tendon. A smaller, similar lesion was present more proximal to the swelling described. Roentgen ray examination showed no bone involvement (Fig. 3). Under local anesthesia both masses were removed. They were attached to the extensor tendon and were well encapsulated. These tumors were described as fibrous with here and there calcified areas. No microscopic examination was recorded. The wound healed well and the patient did not appear again until June 25, 1929 when she complained of two lumps on her finger in the same place as be-

fore These tumors were again removed under local anesthesia They were attached to the extensor tendon and were encapsulated In the gross, the larger nodule appeared fibrous on section It measured three fourths centimeter in diameter Microscopically there were many cells growing in an aimless and disorganized fashion suggesting a sarcoma There were many spindle and polyhedral cells The polyhedral cells had globules and yellowish granules in their cytoplasm—xanthomatous foam cells Some of the spindle cells contained yellow pigment There were also present a great number of multinuclear giant cells the nuclei of which were for the most part central There was considerable blood pigment present in the tissue and in the foam cells (Fig 4) Healing was prompt following operation The patient has not been seen since September 3 1939 Diagnosis xanthomatous giant cell tumor of the tendon sheath

CASE 4 H M No 83677 a man, aged 21 years, was admitted to the Strong Memorial Hospital on May 31, 1934 About 5 years ago he noticed a swelling on the back of the left hand over the middle portion of the wrist joint One year ago a tumor appeared on the palmar surface of the left hand at the base of the ring finger Both tumors have slowly increased in size and now cause interference with his piano playing Examination revealed normal conditions except for the tumors on the left hand There was a rounded, fluctuant non-tender tumor 2.5 by 2.0 by 1.0 centimeters in diameter beneath the extensor tendons at the distal carpal line It was not fixed to the skin and occupied the mid dorsum of the wrist The other tumor was situated in the web of the fourth and fifth fingers on the palmar surface of the left hand It measured 1 by 1 by 1 centimeters It seemed to be attached to the sheath of the superficial flexor tendon of the fourth finger It was firm and slightly tender on palpation The laboratory findings were normal At operation under nitrous oxide oxygen anesthesia, the dorsal tumor was found to have its origin in ligaments of the wrist joint from which it was excised The palmar tumor was attached to the flexor tendon sheath of the fourth finger and extended through within the sheath by a small finger like prolongation for a distance of 1 centimeter It was smooth, rounded, about 1 centimeter in diameter and had a mottled yellowish brown color Microscopic examination of the dorsal tumor showed a cyst-like structure with a thick wall of connective tissue cells Occasional round cells were observed in the wall The tumor from the palmar surface of the hand consisted of dense fibrous stroma made up essentially of fibroblasts Numerous giant cells were present also phagocytes containing brown pigment There were also masses of large xanthoma cells (Fig 5) Diagnosis xanthomatous giant cell tumor of flexor tendon of fourth finger "ganglion," from capsule of wrist joint

CASE 5 K T., No 38090, a boy aged 19 years, was admitted to the Strong Memorial Hospital on

August 25 1930 Eighteen months ago, he first noticed a lump on the lateral surface of the dorsum of his right foot This lump has slowly grown larger There has been no pain except the discomfort from the pressure of his shoe There has been occasional aching in the calf of the leg Two years ago he had a small fracture in this same region, and he believes that the tumor may have started from this His past history was essentially negative General physical examination was normal There was an egg sized non-tender subcutaneous, slightly movable tumor in the metatarsal region on the dorso-lateral aspect of the right foot It felt elastic and, although the skin over it was freely movable, the tumor seemed attached to the deeper structures There were no signs of inflammation The vital signs and laboratory examinations were normal Roentgen ray showed atrophy of the outer side of the right cuboid and of the proximal end of the fifth metatarsal There was a soft tissue swelling, uniform in density, with sharp outline and no calcium deposits in it (Fig 6) Under spinal anesthesia the tumor was exposed It surrounded the peroneus brevis muscle near its point of insertion The tumor was yellowish, granular in appearance, with streaks of denser yellow tissue It was firm and encapsulated, there being no evidence of invasion of the soft tissues or of the contiguous atrophied bones The peroneus longus was easily separated from it The tendon of the peroneus brevis was cut 5 centimeters proximal to the tumor and the bone chipped off distally so that the end of the tendon and the tumor was removed intact The mass measured 6 by 5 by 2 centimeters and weighed 24 grams On cut section the surface was greyish yellow with deeper yellow streaks Microscopically there was an abundant connective tissue stroma and bands of fibrous tissue running throughout There were irregular shaped giant cells with nuclei arranged centrally peripherally and in clumps at the ends There were many areas of cholesterol crystals surrounding which were seen xanthochromic foam cells There were some areas of hemorrhage, degeneration, and signs of chronic inflammation (Fig 7) Diagnosis xanthomatous giant cell tumor of the tendon sheath of the right peroneus brevis Convalescence was uneventful He was discharged on September 4 1930 There has been no further trouble to date

CASE 6 M S No 51028 a woman, 24 years of age was admitted to the Rochester Municipal Hospital on April 4, 1933 She began to have backache and lower abdominal pain in December 1931 following a dilatation and curettage Treatment in the physiotherapy clinic was instituted without improvement In February 1933 pain radiated down her right leg in addition to her other symptoms About 2 weeks later a thickening in the tendo achillis on each side was noted Stretching of these tendons caused pain more marked on the left side Conservative orthopedic measures were instituted without relief It was decided to explore the tendons but sudden development of pain in both shoulders and

wrists directed attention to removal of possible foci of infection. Accordingly the tonsils and several teeth were removed. Careful examination showed nothing of importance related to the swellings of the heel cords. There were no patches of xanthelasma on the skin and the laboratory examinations were all normal. Exploration of the tendons was carried out on May 3, 1933, under nitrous oxide anesthesia. The sheath of the right Achilles tendon had numerous deposits in it which were yellowish ochre in color. On splitting the sheath the tendon itself was found to be about three times the normal size. It was grossly irregular and on palpation numerous nodules were felt throughout its course. The fibers were separated, thus exposing numerous hard lemon yellow tumors scattered between the tendinous fibers. The tumors extended all the way to the insertion of the tendon and almost to the junction with the muscles (Fig. 8). The left tendon presented a picture which was almost identical. Not having any precedent for the treatment of this condition it was decided to pare down the tendons to their proper size and to restore the sheaths. Accordingly, this was done. She made a good recovery and was discharged to the orthopedic clinic on May 15, 1933. Microscopic sections showed tendon fibers which were separated by areas of invasive fibrous tissue. The connective tissue fibers were young and were accompanied by numerous mononuclear and giant cells. The tissue was fairly vascular and had the appearance of chronic granulation tissue. Fat stains revealed many lipochrome granules in the tumor cells. The relation of tumor tissue to tendon fibers in the sections was about equally divided. A diagnosis was made of xanthoma of the tendon sheaths and infiltration with xanthomatous tissue of the tendons themselves (Figs. 9 and 10).

During the summer she became progressively more disabled as the tendons again increased in size. A course of roentgen ray treatments of 450 r strength were given over the tendons until a total dosage of 3300 was reached. There was no appreciable effect from this. It was finally decided that nothing would succeed short of a radical excision of the whole Achilles tendon with reconstruction of a new tendon out of fascia lata. When she entered the hospital for this operation on October 17, 1933, there were tender indurated nodules 1 to 2 centimeters in diameter along both Achilles tendons. On the left side these extended for 22 centimeters upward and on the right side for 14 centimeters. Dorsiflexion was limited by pain on both sides at 110 degrees. Laboratory studies were normal. Resection of the right tendon with reconstruction was done on October 18, 1933. A plaster cast was applied and not removed till November 21, 1933. At that time the wound was well healed, there was no evidence of recurrence and the grafted tendon appeared to function. Physiotherapy was started. An operation similar to that of October 18 was carried out on the left side on November 29, 1933. She has had a long slow convalescence and has practically had to re-

learn how to balance herself before resuming her walking. She now (March 1934) gets about without crutches but has not yet resumed her normal gait. There has been no sign of recurrence of the xanthomatous condition. Sections of the excised tendons were exceedingly hard to cut but showed essentially the same picture as the original sections. This patient offered definite problems in orthopedic and plastic surgery, and her history is being reported in detail by Drs. Young and Harris.

CASE 7. E. N. No. 40340 a girl of 14 years was admitted to the Rochester Municipal Hospital for acute nasopharyngitis on October 29, 1930. While in the hospital a nodule about 2 centimeters in diameter was discovered at the insertion of the right tendo achillis. She said that it had been there several years and had not caused any discomfort. Examination showed that there was a slightly movable non-tender subcutaneous nodule attached to the tissues at the insertion of the tendo achillis. The mass was soft in consistency with two central rounded, somewhat cartilaginous bodies. Under nitrous oxide oxygen anesthesia the tumor was exposed. It was situated directly upon the posterior sheath of the distal end of the tendo achillis. It was not firmly adherent and was easily stripped off. It consisted of two firm whitish, fibrous nodules. On microscopic section the tumor was composed mainly of moderately vascular connective tissue. The vessels were somewhat thickened and there were areas suggesting degeneration (Fig. 11). Diagnosis: degenerated fibroma. She was discharged after an uneventful recovery. On May 9, 1931, there was no evidence of recurrence. She has not been examined since.

CASE 8. A. S. No. 72052 a woman aged 38 years was studied in the medical out patient department for indigestion. On physical examination a tumor was discovered just above the right ankle joint. She said that it had been there for 15 years but had not caused any trouble until 1 year ago. At that time it became tender and increased in size. On examination a tumor measuring 2 by 2 centimeters was noted just above the ankle joint and on the medial side of the anterior tibial tendon. It was firm, ovoid in shape, very tender, and attached to the tendon or its sheath but freely movable under the skin. It was removed under local anesthesia on May 3, 1933. In the gross it appeared as a white fibrous, firm, elongated mass 1 centimeter in diameter at its widest point. The cut surface was homogeneously fibrous and white in color. Upon microscopic examination there were interlacing bundles of fibrous connective tissue cells with rather large nuclei. A thin, fibrous capsule surrounded the mass (Fig. 12). Diagnosis: fibroma of tendon sheath. The wound healed well and she was discharged from surgical care on May 16, 1933. There was no sign of recurrence when examined on March 22, 1934.

CASE 9. A. W. No. 63166 a woman, aged 32 years, was admitted to the Rochester Municipal Hospital on September 25, 1932 for removal of an

moors from both wrists. She had first noticed a swelling on the dorsum of the left wrist 3 months ago. It was not painful and gave her no trouble until 1 month later. It gradually grew in size and became sensitive. There was also a stiffness of the wrist joint. One month ago a similar swelling appeared on the dorsum of the right wrist. Examination showed a rather large swelling on the dorsum of the left wrist. It was not tender measured 4 by 4 centimeters in diameter and seemed soft, almost fluctuant. The swelling over the dorsum of the right wrist was considerably smaller. The tumors were excised under ether anesthesia. A 12 centimeter linear incision was made in order to expose the tumor of the left wrist. It was found to be about the size of an egg and it enveloped all the extensor tendons running up into the forearm under the annular ligament which had to be divided to expose it. It was soft in consistency but did not seem to contain fluid. It was carefully dissected free from the extensors and the anatomical relations were restored. A similar procedure was necessary on the right, the annular ligament again requiring division. Grossly the specimens consisted of a mass of fibrous tissue. In the specimen from the left there was a thin walled cyst 1 to 2 centimeters in diameter in the center of the growth. The cyst lining was rugose and appeared covered by a serous membrane. Microscopic sections showed masses of dense fibrous tissue, richly infiltrated in foci with lymphocytes and plasma cells. There were many fibroblastic appearing cells present (Fig 13). Diagnosis fibroma with cystic degeneration or ganglion with chronic inflammation. Convalescence was slow because of arthritic changes in the joints which prevented full motion. Progressive arthritis has kept this patient in the out patient clinic for the last 3 years. There has been no local recurrence of the tumors on either side.

CASE 10. A. K. No. 46325 a woman, aged 38 years, was admitted to the Strong Memorial Hospital on April 24, 1931. She complained of a tumor of the right knee which had been present for 6 months. It had grown steadily in size and at the time of admission was the size of a hen's egg. Five treatments with roentgen rays had had no effect upon it. Examination revealed an obese woman with otherwise normal physical findings except for the local condition. There was a firm, non tender mass about 8 centimeters in length underneath the flexor group of muscles on the inner side of the right knee. It was movable, deeply placed and felt like cartilage. Special laboratory examinations were negative. There were no changes in the vital signs. The tumor was removed under local anesthesia. It was attached to the semitendinosus tendon about 0.5 centimeter above its insertion into the fascia around the knee. The tumor measured 4 by 6 centimeters and was easily freed from the sheath. The tissue was soft elastic and white with occasional yellowish granular surfaces. Microscopic section showed pale edematous fibrous tissue which appeared to be degenerated and gelatinoid in areas. There were many large, pale

blue staining cells with indistinct cytoplasm. These occurred in vascular spaces, and some of them looked like giant cells. The whole tumor gave the impression of a transition stage to preformed cartilage (Fig 14). Diagnosis synovialblastoma—transitional to chondroma. The convalescence was uneventful. She was discharged on May 4, 1931. There has been no recurrence or further trouble to the present.

CASE 11. T. F. No. 37777 a man, aged 21 years, was admitted to the Strong Memorial Hospital on April 24, 1933. He had had a tumor the size of a walnut removed from the anterolateral aspect of his right wrist at the age of 4, 17 years ago. The patient remembers having a large rounded tumor in this same region beneath the old scar for at least 10 years. It has not changed in size but there was a time 8 years ago when there was pain and tenderness in the mass. In the last few weeks there has been recurrent discomfort which has become severe enough to prevent the use of the hand during the last fortnight. He thinks that he may have brought on this episode by bowling. There have been no constitutional symptoms. General examination showed a relatively normal individual except for the local condition. Locally there was a long, well healed cicatrix on the lateral side of the volar aspect of the right wrist. There was a fusiform, slightly lobulated, resilient non-tender mass measuring 3 by 5 centimeters in diameter attached to the deep structures. The skin over it was freely movable. There were no sensory changes in the hand. Extension of the wrist was limited at 10 degrees, flexion at 35 degrees. The opposition power of the thumb was weak. There were no epitrochlear or axillary glands palpable. Roentgen ray did not show any evidence of bone involvement (Fig 15). Under avertin, local and nitrous oxide anesthesia the scar of the previous incision was removed and flaps dissected, exposing a long cylindrical firm tumor of reddish brown appearance with many dilated vessels running into it. It was not well localized from the surrounding tissue and had to be removed by sharp dissection. It was attached firmly to the annular ligament of the wrist. It was also firmly bound down to the two extensor tendons of the thumb. It was carefully dissected free and removed in one piece. Closure was made in layers with fine catgut and silk. The hand was placed in a cocked up position on a molded plaster splint. Grossly the tumor consisted of an oval mass of tissue measuring 4 by 2 by 3 centimeters. On section it appeared to be dense fibrous septa separating large vascular spaces. It was surrounded by fat and not definitely encapsulated. Microscopic sections showed numerous densely arranged, various sized blood vessels with fibrous tissue surrounding them. One vessel showed a well organized thrombus in its lumen (Fig 16). Diagnosis fibrohemangioma of the tendon sheaths. He was discharged from the hospital on May 1, 1933. The wound healed well. Physiotherapy was started and wrist joint motion restored to normal after 135 months. In March, 1934, the wrist was normal and the tumor had not recurred.

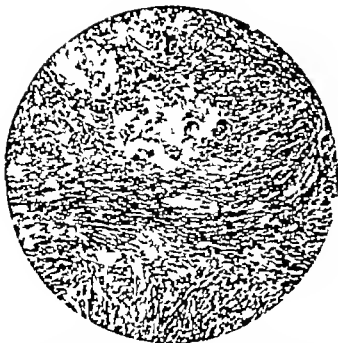


Fig. 1. Case 1. The characteristic spindle cells with intercellular fibrils make up the greater part of the picture. Typical giant cells and phagocytized blood pigment are also present but no xanthoma cells were found in the sections studied. $\times 135$



Fig. 2. Case 3. This area shows many giant cells and the more compact type of connective tissue cells with intracellular blue staining material and suggestions of synovial spaces. $\times 135$

Cases 1 to 6 well illustrate the features of the commonest tumor of the tendon sheaths. These giant cell tumors are characterized by an insidious onset and a relatively slow growth. They are most commonly seen on the tendon sheaths of the hands, and next most frequently on those of the feet. Then there is a scattering of localization to the tendon sheaths about the wrist and ankle joints. Rarely these tumors occur more proximally to the body. Their seat of origin on the hands and feet makes discovery rather early. Even despite the usual delay of the patient in seeking attention the size of the tumors is rarely greater than that of a walnut and usually it is even smaller. The tumors about the wrist and ankle tend to be larger. In general the more peripheral the position the smaller the size and vice versa. There have been cases reported the size of a fist (Ali Krogius Case 1), the size of a goose egg (Kurtz) of unusual size" where the tumor occupied the whole central part of the foot (Ragius) and as large as a hen's egg (Sprenger) (Gonzalez Aguilar). Occasionally the growth becomes accelerated after a slow development over a period of years. Symptoms which may arise are due to

limitation of function of involved tendons or pressure on nerves. When a large nerve is involved paroxysms of pain may occur as in Kurtz's case. Pressure on bones may be so gradual as to cause no symptoms but may result in erosion, or replacement of bone (as in Harbitz's Case 4 or Ragius's Case 1) or pressure atrophy with deformity (Esau and Hueckel) and (author's Case 5), occasionally infection of the tumor occurs (author's Case 2). The tumors are usually smooth, rounded, or lobulated. They give an impression of being hard or elastic. Sometimes they are slightly tender on firm pressure. The skin is freely movable over them and they change position with motion of the involved tendon. Sometimes they occupy a position lateral to the sheath. Occasionally more than one tumor is present (Jebens case) (author's Case 3). The tumors are well encapsulated and shell out readily at operation. The tendon and surrounding structures are not involved as a rule. Attachment to the periosteum may occur when such a tumor arises from a bursa (Hertzel). Very rarely invasion of the tendons themselves is noted (Ollerenshaw's case, author's Case 6) but these two examples are



Fig. 3. Case 3. The roentgenogram shows a soft part dense swelling without involvement of the bone.

the only cases of this kind in the literature. There is rarely a recurrence if operation has been properly executed but when it is incomplete recurrence may take place (author's Case 3). Metastasis from this type of tumor is not reported. In gross appearance the tumors are varied in color. White, grey, red, brown, and yellow are frequently described as the predominant hues. When the characteristic bright yellow or red brown spots are noted interspersed through the tumor, the surgeon can be reasonably sure that he is dealing with a growth of this type.

The microscopic appearance of these growths is also perfectly characteristic. The basic cells of these tumors are either typical fibroblasts with abundant or sparse intercellular fibrils or more compact blunted connective tissue cells with ovoid nuclei and homogeneous blue staining intercellular material. These probably represent the synovial connective tissue cells and as a further evidence of it synovial spaces may be encountered in these areas (King). In addition to these cells, there may be found giant cells, xanthoma cells, blood pigment, and cholesterol crystals. The giant cells and xanthoma cells may be taken to represent the endothelial structures in the tumors, reacting in response to the presence of the foreign bodies—blood pigment and cholesterol crystals. Giant cells and xanthoma cells are actively phagocytic and may disappear when the foreign material has been cared for



Fig. 4. Case 3. In the upper left hand corner there are xanthoma cells with foamy cytoplasm and central small dark staining nuclei. The rest of the section shows dense fibrous tissue with giant cells and occasional areas of blue staining intercellular substance.

Consequently the presence of these scavengers is more or less fortuitous but of definite diagnostic value as an indicator of the nature of the growth.

There has been considerable discussion and difference of opinion in regard to the true classification of these growths (3, 10, 13, 15). They have been classified as inflammatory by many observers, the reaction to trauma being assigned as one etiological factor. Many look upon them as granulomata. Still another group considers them as due to imbalances in the metabolism of the lipoids, especially cholesterol. And lastly they are thought to be true benign neoplasms by a large number of competent pathologists. In many respects they bear a close analogy to the giant cell tumor of bone. It has long been known that there are infiltrations of the skin and other organs with lipoid-containing xanthoma cells in systemic diseases such as diabetes, nephrosis, etc. Also any systemic condition which disturbs the lipoid metabolism such as jaundice may be associated with hypercholesterolemia and a deposit of lipoids in certain locations. Nevertheless it does not follow that there is always a systemic derangement in these cases simply because giant cell tumors of tendon sheaths have been found in the presence of such a systemic disorder as in the



Fig. 5. Case 4. There are xanthoma cells in the central part of the section. Phagocytic giant cells are prominent on the left. The variation in size and shape of the connective tissue cells is characteristic. $\times 150$

cases of McWhorter and Weeks, Kusnetzow sky and Ollerenshaw. In fact quite the contrary has been the result in many carefully studied clinical cases. For instance in our Case 6 the blood chemistry and cholesterol determinations were repeatedly within normal limits. This case might reasonably have been expected to be on a systemic basis because of the bilateral distribution of the tumors and the close resemblance to that of Ollerenshaw. A very similar analogy obtains for giant cell tumors of bone in the presence of hyperparathyroidism. Collections of giant cells in this condition may be found in relation to the cystic areas in the bones but these do not constitute giant cell tumors any more than the patches of xanthelasma in the skin constitute giant cell xanthomatous tumors. Ely has reported the simultaneous occurrence of a giant cell tumor in the fibula and in the peroneal tendon sheath but there are no other cases of this kind recorded. The weight of evidence at present seems to indicate that the localized growths of the tendon sheaths are not the manifestations of a general disease but true benign neoplasms. It is an open question whether these growths could be made to take on malignant characters by repeated insults as is certainly the case in giant cell tumors of bone. It is unfortunate that so many terms have been used to describe the benign giant cell tumors of the tendon sheaths. Until further evidence is forthcoming it seems that it



Fig. 6. Case 5. The roentgenogram shows the dense soft part shadow and the pressure atrophy of the outer aspect of the cuboid. It is sometimes difficult to differentiate between a secondary involvement of bone and a primary bone tumor with extension to the soft parts.



Fig. 7. Case 5. To the left of the section there is a mass of cholesterol crystals next to which are collections of typical xanthoma cells. In the lower right hand corner is a mass of blood pigment. Giant cells are present scattered throughout. Compact blunted connective tissue cells with much bluish staining intercellular material comprises the bulk of the section. $\times 75$



Fig. 8. Not only were the sheaths involved on both sides but the tendons were greatly enlarged and infiltrated with tumor nodules.

would be well to regard the designations giant cell sarcomata, giant cell myelomata or sarcomata with myeloplaxes as incorrect.

Cases 7 to 11 illustrate some of the variations which may be encountered in these tumors of the tendon sheaths. Case 7, for example, might be considered a pure fibroma of adult type cells. The section suggests in places that the cells are undergoing degeneration. It is quite likely that this is evidence of secretory activity with no normal outlet. There are many slit like openings which may represent synovial spaces. In Case 8, on the



Fig. 9. Case 6. A small area with giant cells is seen in the lower central portion of the section. Just above it are cells containing biochrome granules. On special fat stains these cells are quite numerous and are interspersed throughout the field. The main mass of the tissue consists of relatively young fibroblasts replacing and invading the normal tendon structure which is shown traversing the upper part of the field. $\times 75$.

other hand, the fibroma consists of interlacing bundles of a more immature type of connective tissue. This may well be the late stages of a synovioma which is going over into pure fibrous tissue. Case 9 is a beautiful example of one of these synovial sheath tumors which are loosely grouped under the term ganglion. There are clearly reproduced synovial fringes and papillary projections into spaces occurring in this tendon sheath tumor. The infiltration with cells of a chronic inflammatory type further emphasizes the similarity to the synovial villi seen in chronic arthritis. These tumors were clinically not the typical ganglia but much more truly neoplastic in nature. It is certain that they would be considered neoplastic by most pathologists as the main mass of the tumor consisted in dense fibroblastic tissue. The fact that these synovial cells have gone on to complete differentiation with reproduction of the characteristics of synovial membranes is a true indication of their origin. It is customary to look upon ganglia as fibrous tumors which have undergone cystic degeneration. It would seem much more logical to look upon them as tumors originating from synovial cells which have pre-



Fig 10. Case 6. This section shows the normal tendon—dark staining—being crowded aside and invaded by an actively growing connective tissue. $\times 75$

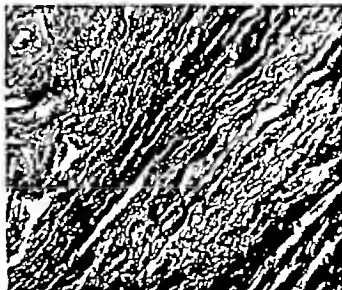


Fig 11. Case 7. The section is mainly composed of connective tissue cells of adult type. There are numerous slit-like synovial spaces. $\times 75$

served their function of secreting mucin for which there is no outlet and hence a cyst forms. Certainly pathologically there is little evidence to support the theory that the cysts arise from degeneration in these tumors. Case 10 shows that the synovial cells possess remarkable powers of differentiation. The cells are blunted the nuclei rounded. There is an abundance of blue staining mucinous material as an intercellular ground substance. The whole tumor shows this structure quite uniformly and areas such as that in the center

of the illustration represent a transition to cartilage. In time this tumor would have undoubtedly become a true chondroma of the tendon sheath. A number of examples of chondroma of the tendon sheaths have already been reported (Janik, Brenckmann and Jung, Chevrer). Case 11 affords a perfect example of a rather uncommon tumor of the tendon sheaths which had recurred after incomplete removal years previously. Burman and Mil

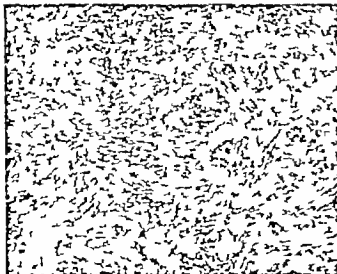


Fig 12. Case 8. There are many interlacing bundles of connective tissue cells with numerous fibrils in this section. It may be considered a fibroma of the tendon sheath. $\times 75$.



Fig 13. Case 9. Projecting papillary growths of synovial origin with chronic inflammatory infiltration found in the central portion of a dense fibrous tissue tumor. This well illustrates the origin from synovial connective tissue. $\times 75$

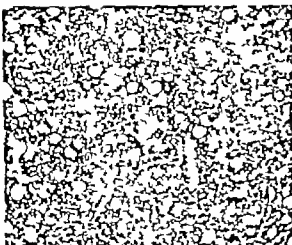


Fig. 4. Case The central portion of the section shows early cartilage forming from synovial cells. $\times 75$

gram have assembled 16 cases of these hamangiomas. \ Delta Mano and Princigalli in 1933 added typical examples to the literature



Fig. 15. Case 11. Large soft part density without bone involvement. It is subcutaneous and surrounds the tendon.

There were no instances in our cases of the more unusual forms of tumors such as lipomata (Strauss White Brandão Chiarissimo Valdoni), lymphangio-endotheliomata (Faldini Scagliosi Huguenin and Oberling Princigalli) nor of the malignant varieties of which there are reported cases scattered through the publications on collected tendon sheath tumors (Tourneaux Harbitz Janik, etc.)

At this point it seems logical to consider the embryology and biology of the synovial cells. Recent studies have furnished increasing evidence of their undoubted mesenchymal origin. It has been established that all cells having such an origin possess the capacity of reverting to the primitive fibroblast (12). From tissue culture studies on synovial cells, Vaubel has been able to demonstrate that these cells produce much not as a cellular degeneration but as a true secretion. He regards this mucin production as a ground substance of the synovial tissue analogous to the intercellular substance of the cartilage matrix except that it persists in a liquid state. Under certain conditions the synovial cells exhibit a decided polymorphism—varying in contour from round to polygonal to almost epithelial appearances on the one hand and to typical spindle forms on the other. There is also morphological evidence that the synovial membrane is a spe-



Fig. 6. Case The macroscopic picture is of a space filled with red blood cells surrounded by a wall of fibrous tissue. The whole section is typical for fibrohemangioma. $\times 75$

cialized type of connective tissue (Segale). On studying the histology of normal and abnormal synovial membranes, the importance of the varying underlying supporting tissue was brought out by Key. These supporting tissues offer a considerable range of morphology from areolar to adipose to fibrous in nature. King has drawn attention to the transitions of the synovial cell through a pseudo-cartilage to a true cartilage cell in the regions where the synovia attach to the cartilage. The richness of the blood and lymphatic supply to the synovial membrane offers a chance for endothelial elements and their derivatives to take part in the tumor formation. In summary, the synovial cell is one which enjoys multipotential variations. Under some conditions it may revert to the primitive type spindle form connective tissue but it is closely related to the cartilage and bone cells and in certain areas possesses the ability to differentiate in the direction of cartilage. This primitive synovial cell may be designated as a synovioblast to correspond to similar chondroblasts and osteoblasts of the precursors of cartilage and bone.

The tumors which arise from the tendon sheaths then may consist of the synovial cell and its variants as the central figures. But the supporting areolar fibrous or fatty tissue may also take a part in the formation of the growth, and the endothelial elements may enter from the richness of the blood and lymphatic supply. From the endothelium, scavenger cells such as macrophages, giant cells and reticulo-endothelial cells may escape to lend variety and color to the tumor. The pathologist has as his task the sifting of the essential from the non essential elements. He must, if possible, assign the proper weight to each component of the growth. If proper recognition can be given to the site of origin, it may be useful to draw up a tentative classification which has the merit of applying equally well to the growths of tendon sheaths, bursae and joints. Such a schema is herewith subjoined in the hope that it may serve as a working basis for a more complete classification of these tumors as material accumulates.

Synovigenic tumors. Tumors having their origin in the synovial membranes of tendons, bursae, joint capsules and joint linings.

Benign

Tendon sheaths		Joints and Bursae
a. synovioblastoma	ganglion	synovioblastoma
b. fibroma		fibroma
		intra-articular
		extra articular
c. chondroma or osteochondroma		chondromatosis
d. giant cell xanthoma		giant cell synovial membrane tumor
e. angioma		angioma
hemo		hemo
lymph		lymph
f. lipoma		lipoma

Malignant.—Synovigenic sarcomata.—These contain many of the elements derived from the synovial membranes or from the tissues in apposition to them. The cases reported are as yet too few in number to separate out anatomic types.

Malignant involvement of tendons, bursae or joints practically never occurs.

CONCLUSIONS

Tumors of the tendon sheaths are closely related to tumors of joints and bursae.

The basic cell of all these tumors is the synovial cell.

The synovial cell is a modified mesenchymal cell with multipotential qualities.

It may revert in one direction to the fibroblast or may go over into cartilage and bone in the other.

Evidence is presented to support this contention and a tentative classification of tumors of the tendons, joints, and bursae is proposed.

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INDICATIONS FOR THE SURGICAL TREATMENT OF CARCINOMA OF THE STOMACH

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The Mayo Clinic

THE cure of cancer of the stomach by surgical treatment has been accomplished in a sufficient number of cases to remove any doubt that cure is possible under certain circumstances. It is unfortunately true, however, that the number of cures in relation to the incidence of the disease is pitifully small. If, however, the possibility is considered of the curability of carcinoma of the stomach when it is still confined to the walls of the stomach and is widely removed, it is found that about 50 per cent of the patients are alive and apparently without recurrence 5 years after operation. The earliest possible recognition of the growth and its prompt and thorough removal therefore is the hope of the patient with carcinoma of the stomach. In addition to the possibility of cure, surgical treatment properly applied in many of the less favorable cases will prolong life, will protect against disagreeable complications and in many respects may fully justify such treatment.

In regard to the most important factor in increasing the percentage of cures that is early diagnosis, it is an unfortunate paradox that although the disease readily can be identified in its early stages, this is rarely done. The competent fluoroscopist may, in rare instances, fail to detect early carcinoma of the stomach, but all too often the first fluoroscopic examination discloses advanced disease. The chief reason for this frequently has been pointed out, namely, the early clinical signs of carcinoma of the stomach are often so vague and apparently so insignificant that the necessity of the only examination (roentgenological) by which the early symptomless lesion can be detected is easily overlooked. To avoid this error, which interferes so seriously with increasing the efficiency of treatment of the disease, is a problem of modern medicine which presents unusual difficulties.

When a pre-operative diagnosis of carcinoma of the stomach has been made or a le-

sion which may be malignant has been demonstrated roentgenologically, the basic indication for treatment is that unless definite metastasis can be demonstrated, surgical exploration of the growth is warranted. This principle cannot always be followed, for there may be clear evidence, such as involvement of the cardia, that the growth is irremovable. The conscientious surgeon, however, should view the situation from the standpoint that cure may sometimes be brought about in cases in which, on pre-operative examination, the disease appears too far advanced for cure. Such a view tends, of course, to decrease the rate of resectability when based on the number of cases in which exploration is made, to increase the rate of resectability when based on the number of patients whose condition is diagnosed as carcinoma of the stomach, and also to increase the operative mortality rate. The effectiveness of surgical treatment is greater with such practice, however, both in respect to the number of cures and to the degree of palliation.

The question of whether metastasis is present in carcinoma of the stomach is of first importance in determining whether or not surgical treatment is indicated. Fortunately, early distant metastatic growths occur in situations in which they can be detected by careful examination and when they are found the situation is clarified in so far as any prospects of cure are concerned, but when they are overlooked, unnecessary exploration may be made. The most common sites of distant signs of incurability are the supraclavicular lymph nodes and the peritoneum of the rectal shelf. Nodules in either site denote incurability, but not always undesirability of exploration. When enlarged lymph nodes are palpable in the supraclavicular area, and the patient is known to have carcinoma of the stomach, the nodes must be considered metastatic until proved otherwise. Usually they

fit into a picture already identified as that of inoperability and the assumption that they are malignant is warranted. Occasionally however the primary growth is small obstruction is present or is impending and the enlarged lymph nodes are not as typical of metastatic nodules as those which usually are encountered. It is then necessary to excise, under local anesthesia, a nodule satisfactory for microscopic examination and treatment is then directed according to the result of this study. If the excised node is malignant, operation is always contra indicated even if marked obstruction is present, for the life of the patient is so near an end that non surgical treatment of the obstruction is best. If the nodes prove to be inflammatory and there are no other detectable metastatic growths, exploration is indicated unless the lesion or its local extension or other factors make exploration unwise.

Involvement of the peritoneum of Douglas pouch should be most carefully sought for as this may be the site of not only an early but also of the only metastasis. Rectal examination of patients with carcinoma of the stomach should never be omitted should be made after the bowel is cleared of fecal material and the patient should be examined in both the lithotomy and knee-chest positions. Peritoneal implantation in Douglas pouch is usually sufficiently well defined either because of the almost cartilaginous feeling of the tissue as described by Blumer or because a distinct nodular mass is fixed to the pelvic peritoneum as it is reflected from the anterior aspect of the rectum. Not infrequently however a sense of rigidity of this portion of the peritoneum may arouse only suspicion that implantation has occurred, and in the absence of definite nodules exploration of the gastric lesion may be advised if it is otherwise indicated. The mechanism of pelvic implantation from a gastric lesion probably differs from that of supraclavicular metastasis. The latter obviously takes place through the lymph channels, and the former apparently is by direct implantation of cells. The most striking example of such implantation is seen in the Krukenberg tumors examples of such tumors have been encountered in the form of large

malignant pelvic tumors secondary to small, non-perforating carcinomata of the stomach which caused no digestive disturbance and which were not detected until the pelvic tumors had been removed. It is because these rectal secondary growths are probably true implants that operation on the primary growth may occasionally be advisable even when secondary rectal growths are definitely present. For example the patient who is in good general condition but who has an antral lesion that is producing obstruction may be greatly benefited by operation both in respect to relief of symptoms and length of life even if growths in the rectal shelf are encountered in the course of the pre-operative examination.

The more common adjacent sites of metastasis are the liver and the region of the umbilicus, and when such metastatic growths are demonstrable clinically operation is contra indicated regardless of other circumstances. A nodule in the region of the umbilicus may be so small that its excision is advisable to permit more positive examination and the difficulties of determining by clinical examination whether or not an enlarged liver is secondarily involved, are well known. The applicability in these cases of more recent methods of roentgenological visualization of metastatic nodules in abdominal organs by administration of thorotrast is as yet unknown. If doubt exists as to whether metastasis to the liver has taken place and if circumstances otherwise indicate that exploration is warranted, it should be done. The indications for surgery when intra abdominal metastasis is encountered after the abdomen is opened will be discussed later.

Extra-abdominal metastasis is relatively rare with carcinoma of the stomach, except in the supraclavicular lymph nodes. For example pulmonary metastasis is so rare that it is not the routine in The Mayo Clinic to make a roentgenogram of the thorax in these cases. In a study of all the roentgenological examinations of the lung made in the clinic up to 1930 Kirklin and Ochaner found that pulmonary lesions definitely secondary to carcinoma of the stomach were extremely uncommon and only 3 instances could be found. There was 1 case each of involvement of the right lung the left lung and both lungs. In 2 of

these cases the lesions were circumscribed in the other, the lesion was of the infiltrative type. The suspicion, therefore, that the disease is more advanced than the local lesion makes it appear to be, should be confirmed by roentgenograms of the thorax.

Abdominal metastasis other than the forms mentioned are not infrequently detectable or suspected by the demonstration of fluid or of extragastric masses and such findings definitely contra indicate any surgical treatment.

The significance of irremovable metastasis discovered at exploration therefore is incurability, but, as will be pointed out, such growths may in certain circumstances not preclude the possibility of long continued palliation by removal of the primary growth.

Examination of the upper part of the abdomen frequently will disclose findings of importance in deciding as to the advisability of operation and when such information is correlated with the roentgenological report of the character of the lesion as shown by fluoroscope and roentgenogram the possibilities of surgical treatment become more predictable. There are, however, frequent apparent inconsistencies between physical findings and surgical possibilities. The most common fallacy is that the non palpable growth is more likely to be found removable than the palpable one but the reverse is often true. The large growth often is of the colloid type with sharply defined margins whereas the small lesion may extend by infiltration and have little tendency to formation of tumor. When the growth can be palpated its mobility is of extreme importance in estimating the possibility of removal. A very large tumor freely movable particularly laterally, is perhaps more likely to be found resectable than a small tumor which is more or less fixed. A high lying lesion the edge of which presents at the left costal margin on inspiration on shifting the position of the patient may be found to be mobile and accessible. I have observed cases in which the condition apparently was inoperable because a tumor was situated in the fundus and was concealed by the thoracic wall, however the growths were readily removed because they involved chiefly the greater curvature. The large fixed tumor is almost always inoperable

and when it extends to the right enough to make difficult its differentiation from an enlarged and involved liver exploration should be advised against. Multiple tumors are also almost certain evidence of incurability, for they usually represent malignant infiltration of the great omentum.

The correlation of physical findings with the roentgenological report is exceedingly important and is later discussed.

The age of the patient is important in considering the advisability of operation for gastric carcinoma. Other things being equal, the younger the patient the more clear are the indications for exploration and it is on relatively younger patients that the most extensive operations are justified. Total gastrectomy for example does not seem a reasonable procedure if a patient is 70 years of age whereas the same procedure might be justifiable if a patient were 50. The possibilities of cure of younger patients moreover, are as good as when patients are older a fact which is contrary to what I believe is the general impression. Gray for example in a study of 273 patients who obtained 5 year cures following resection done in the clinic, showed that the percentage of cures was as high among patients who were in the decade of life from 35 to 45 years as among those who were in the decade from 60 to 70 years. The practice, therefore of attempting to carry out gastrectomy for the more extensive lesions of young patients is sound.

The condition of the patient is not always easy to judge correctly, in so far as the operative risk is concerned. Extremes are significant. The patient who is markedly overweight constitutes a poor risk as does the patient who has lost much weight particularly if loss has been rapid. Of these, however, the patient who is underweight apparently has less liability to complications such as those referable to the lung than have patients who are overweight. In the average case estimation of the condition of the patient who has no other organic disease is largely speculative since the factors which have to do with recovery are too intangible to be measured. The mortality rate of gastric resection among women for example, is consistently lower than

fit into a picture already identified as that of unoperability and the assumption that they are malignant is warranted. Occasionally however the primary growth is small obstruction is present or is impending and the enlarged lymph nodes are not as typical of metastatic nodules as those which usually are encountered. It is then necessary to excise under local anesthesia, a nodule satisfactory for microscopic examination, and treatment is then directed according to the result of this study. If the excised node is malignant, operation is always contra indicated even if marked obstruction is present for the life of the patient is so near an end, that non-surgical treatment of the obstruction is best. If the nodes prove to be inflammatory and there are no other detectable metastatic growths exploration is indicated unless the lesion or its local extension or other factors make exploration unwise.

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ological report. This patient weighed 75 pounds (34 kilograms) at the time of operation, she gained 35 pounds (15.9 kilograms) after operation and lived more than 2 years in comfort and enjoyment of an active life before succumbing to hepatic metastasis.

The limitation of roentgenology in the field of gastric malignancy is in identifying the small ulcerating lesion and the experienced roentgenologist will be cautious in giving a positive opinion as to the question of malignancy in the presence of these small lesions. Kirklin and Eusterman recently have presented some important criteria on which at least a provisional diagnosis can be given. In so far as the indications for surgical treatment of the questionable gastric lesion is concerned I believe it is generally accepted that unless an ulceration continues to exhibit a benign character by consistent and definite healing it should be assumed to be at least potentially malignant and should be dealt with accordingly.

The indications for operation in cases of gastric carcinoma require selection of the optimal time for operation. The risk of resection under the most favorable conditions is not great considering the seriousness of the problem, but the attainment of a low mortality rate provided it is consistent with the highest possible rate of operability and thorough removal, is an accomplishment demanding most meticulous care in all the details involved in treatment. The patient should then be in the best condition possible for operation and this frequently requires hospitalization so that the effects of obstruction may be overcome, dehydration counterbalanced, the stomach cleansed, and nutrition improved as much as is reasonably possible.

Exploration for carcinomas of the stomach should be carried out under anesthesia adequate to permit accurate determination of what can be accomplished. For this reason local anesthesia must be used with a consciousness of its limitations. Abdominal wall block is frequently employed in the clinic to permit exploration for carcinoma of the stomach but in those cases in which it is not immediately apparent that either the growth is removable or that peritoneal implants give

evidence of inoperability, a general anesthetic is given to permit thorough examination to determine the extent of the disease. The incision should vary with the situation of the growth. An incision in the median line is satisfactory for lesions of the body and antrum, for fundic lesions or for those in which total gastrectomy is contemplated, a left rectus incision is advantageous.

Unless it is clearly apparent that the disease is incurable because of peritoneal implants careful abdominal exploration should first be made. This exploration should include the routine examination which would disclose any independent lesions or disease which might be detectable. Examination of the gall bladder and of the biliary tract therefore is of particular importance because of the frequency of disease in these structures. The importance of a record of any other lesion within the abdomen cannot be overestimated. As an illustration of this fact, I can recount the case of a man aged 70 years on whom I operated for an extensive carcinoma of the stomach, and for which subtotal gastrectomy was performed, supposedly as a palliative procedure only, since the apparently involved lymph nodes could not be removed. The gall bladder was almost entirely filled with small stones. Any operation on the gall bladder, however, was contra-indicated at this time. The patient made a satisfactory convalescence from operation, and 4 years later after a period of pain and distress, jaundice appeared. If it had not been known that gall stones were present, the jaundice might have been looked on as evidence of recurrence of malignancy in the liver or biliary tract. The excellent condition of the patient, however warranted further operation, and at this time 4 large stones were removed from the common bile duct. It is of interest that there were no calculi in the gall bladder and there was also no evidence of any recurrence of carcinoma in the upper part of the abdomen, the unremoved, enlarged lymph nodes which it had not been possible to remove at the time of the gastrectomy had entirely disappeared. Recently the patient has reported himself to be in excellent health 2 years after the last operation.

The chief importance of exploration however is to determine whether distant and irremovable abdominal metastatic growths are present. The rectal shelf should always be explored since peritoneal implants may be present which were not detectable during the clinical examination. If definite implants are found but no other evidences of peritoneal involvement can be discerned surgical treatment of the lesion must be considered from the viewpoint that the disease is obviously incurable. In spite of this the growth occasionally is so situated that resection is not only possible but advisable because of the relative ease with which resection can be done and because of the protection it will afford the patient against the early onset of obstruction. The presence of peritoneal implants clearly contra-indicates any attempted palliation by surgical means.

Recognizable metastasis in the liver is usually a definite contra-indication to any surgical procedure but the apparently isolated small, metastatic nodule in the liver may not be sufficient reason for not removing an operable growth. As a matter of fact I have seen some extraordinary examples of the length of time up to 3 and 4 years that a patient may live with metastasis to the liver after the primary growth has been removed. The circumstances under which resection is advisable in the presence of metastasis are, however most exceptional. One of these favorable circumstances is present when there is no evidence in the general condition of the patient that the hepatic involvement has progressed to a point at which function is interfered with.

The significance of involvement of the regional lymphatic structures is extremely important in deciding whether or not operation is advisable. The greatest variability exists in the extent and the degree of such involvement. Widespread involvement of the regional lymphatic structures is a very unfavorable prognostic sign. It should never be forgotten however that cure is still possible even though the disease has extended into the adjacent lymphatic structures. I have seen many patients who have been cured but who at the time of operation had such widespread involvement of the lymph nodes that the

operation was undertaken as only a palliative measure. Therefore only one conclusion can be drawn namely that with wide removal of the primary growth, but not of all of the involved lymphatic structures, occasionally the patient has enough resistance to the disease to prevent its further extension. This possibility in surgical treatment of carcinoma is worthy of considerable further investigation. The decision as to whether operation is indicated, therefore will be governed chiefly by the character of the growth itself because of these known facts and because of the uncertainty as to whether lymph nodes are involved.

The significance of involvement of the 4 major groups of lymph nodes about the stomach is important, since it has been my experience that the suprapyloric and infrapyloric groups, if involved are of more serious prognostic significance than those along the greater curvature and the lesser curvature. This is probably because it is more difficult to carry out widespread removal of the former 2 groups of lymph nodes than of the latter. Immediate microscopic examination of a lymph node, if there is widespread enlargement of nodes, is extremely important since a negative report in so far as malignant involvement is concerned is of real significance.

Examination of the growth itself should be most thorough. As has been mentioned before the patient should be sufficiently relaxed so that there is no interference with maximal mobilization of the stomach. If the patient is straining the impression may be given that the stomach is fixed because of the advanced disease. An entirely different picture may be given when there is adequate anesthesia. In this mobilization the great omentum should be pulled outside of the abdomen. Unfortunately in many cases, it seems apparent that the growth itself does not permit complete removal because of extragastric extension but this should be made certain before such a decision is reached. Unless it is clearly apparent that the growth is irremovable, the lesser peritoneal cavity should be widely opened through the gastrocolic omentum to inspect the extent and the character of the posterior perforation. If it is not certain that incurable

penetration of the pancreas has occurred, and if the growth is otherwise removable, resection should be carried out because in many instances the posterior attachment is found to be merely an inflammatory one. If superficial invasion of the pancreas by the malignant disease has occurred, cautery excision of the area may at least give possibilities of cure. Perforation against the under surface of the liver is not necessarily a contra indication to removal of the growth, since it may be found that what is apparently direct involvement of the liver is only an inflammatory attachment, and if extension of the growth in other directions permits its removal, attachment to the liver should not stand in the way of removal.

If the growth proves to be unattached to the surrounding structures or such attachment does not necessarily interfere with the advisability of resection, examination of the extent of the growth in the stomach is the next step. It is fortunate that carcinoma, except in its extremely late stages does not extend beyond the pylorus into the duodenum, but this fact is perhaps counterbalanced by the tendency of the disease to progress upward toward and along the lesser curvature rather than along the greater curvature. This feature most often explains inoperability and also increases the difficulty of thorough removal when the growth is resectable.

A study of the infiltration by carcinoma of the stomach showed as Cuneo first pointed out the tendency of carcinoma to extend through the submucous lymphatic structures toward the lesser curvature more rapidly than toward the greater curvature. If therefore the carcinoma is of the infiltrating type examination should be particularly carefully made of the extension upward along the lesser curvature, to detect, as accurately as possible, the limits of this involvement. There is however the very important point in this connection that thickening of the gastric wall should not be confused with carcinoma. Such differentiation of course is not made without difficulty but the extent of invasion of actual malignancy usually is definite and it has been my experience that one is more likely to err in saying that thickening in the gastric wall is carcinoma rather than that it is not. Definite

involvement of practically the entire lesser curvature is usually a contra indication to radical operation. The exception, however is in those rare cases in which the entire stomach is involved in the infiltrating type of carcinoma which results in what is called *limitis plastica* type, it is in this type that total gastrectomy is most likely to be feasible. Unfortunately, this infiltrating type of carcinoma is most difficult to cure, and it is reasonable to assume a pessimistic attitude toward extremely radical procedures for this type of carcinoma because of the great rarity of cure. On the other hand the ulcerating or the colloid types of carcinoma are much more clearly demarcated and microscopic evidences of carcinoma were never found more than 4 centimeters beyond the edge of the area in which there was gross evidence of disease.

One may assume therefore when encountering the ulcerative or colloid type of carcinoma, that determination of extension of the disease by palpation is accurate, and if the growth is removable at all, removal can be undertaken without fear of encountering unexpected extension of the disease beyond the point at which it was identified. In the ulcerative and colloid type the more the growth encroaches on the greater curvature, the greater will be the prospects for removal, because of the relatively easy mobilization of the growth throughout its entire extent, the gastrosplenic omentum can be divided easily and the greater curvature completely mobilized. The largest tumors which may still be operable are of the colloid type. It is extremely important that this fact be kept in mind, because the very size of the tumor may give the impression that it is irremovable and yet resection may be relatively easy to accomplish. A decision as to whether resection is justifiable or not depends also to a considerable extent, on the type of stomach in which the growth has occurred. In those cases in which the stomach is small and high lying an infiltrating growth may be clearly inoperable, whereas a similar growth of the asthenic patient with a prolapsed stomach may be operable. Similarly, with the extremely large ulcerating or colloid type of carcinoma total gastrectomy or almost total gastrectomy is

justifiable in certain types of stomach, whereas it would not be reasonable in other types.

If resection seems to be justifiable there are many variations in the methods by which it may be accomplished. In so far as general principles are concerned the growth should be removed as widely as possible gastric continuity should be re-established without undue tension and mechanical function should be perfect. There is no reason, of course, in operations for carcinoma, of the type of operation being adapted to influence gastric chemistry. Detailed description of methods is unnecessary. In a general way it is advisable that the stomach after resection be reunited to the jejunum by one of the many methods advised for this. Re-establishment of continuity by reuniting the stomach and duodenum following resection after the Billroth I method is inadvisable because if recurrence takes place it is likely to develop in the vicinity at least of such an anastomosis and be responsible for obstruction. The more extensive the resection, the more is an anterior anastomosis between stomach and jejunum indicated. This anastomosis simplifies the operation is equally satisfactory from the mechanical standpoint, and because of its greater ease of performance carries a lower mortality rate in dealing with extensive growths. In total gastrectomy there is greater risk of infection than in other procedures and of failure of the anastomosis between esophagus and jejunum to heal. The properties of healing therefore should be augmented as much as possible by providing for administration of fluids and nourishment by a catheter placed in the jejunum. Rarely is local excision of carcinoma to be preferred. Indications for such a procedure are limited to high, well circumscribed growths involving the greater curva-

ture. Excision of such growths, with direct closure is an excellent method of avoiding operative risk, and of accomplishing just as thorough removal of the disease as by the usual gastrectomy.

So far as palliation by operation is concerned with the exception of gastric resection exclusion of the growth is by far the most effective method of bringing about palliation, and I believe there is a much wider application for this operation than it has been accorded. The fact that the growth can be permanently excluded from all contact with food, and gastro-intestinal continuity be made completely independent of the disease, is of great importance and patients not only live much longer than they live after gastro-enterostomy as a palliative procedure but usually in complete comfort in so far as digestion is concerned. Gastro-enterostomy too frequently fails to accomplish what it is hoped to do as a palliative procedure.

If operation for gastric carcinoma is carried out along the general lines that have been outlined, we have found in the clinic that the rate of operability is approximately 45 per cent, the mortality rate for gastric resection can be kept at approximately 10 per cent. The possibilities of cure of cancer of the stomach are shown by the fact that of several series of consecutive cases in which gastric resection was carried out in the clinic, an average of 18 per cent of the patients are alive and apparently well after operation regardless of the extent of the disease at the time of the resection. If those cases are selected in which the disease is still confined to the stomach that is in which there is no lymphatic involvement the percentage of patients alive and apparently well 5 years after operation is 49 per cent.

FRACTURES OF THE LATERAL CONDYLE OF THE TIBIA CLASSIFICATION, PATHOLOGY, AND TREATMENT¹

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THE amount of disability caused by a fracture of the lateral condyle of the tibia is very serious because a genu valgum more or less marked is always present and the frequent dislocation of the fragments into the joint cavity and the fragmentation of the meniscus serve to cause a chronic arthritis that steadily weakens the knee joint by softening the ligaments so that in addition to the lump and deformity of the limb a disabling arthritis is present. We have treated these conditions in various ways—both conservative and operative—and we are certain that fully 40 per cent could be markedly improved with an open operation because the open operation secures a more even bearing surface and the need of a secondary operation to remove loose fragments of cartilage and bone or fragmented and displaced menisci is obviated. The day is past when an individual with a marked lump or deformity of a limb can obtain employment without a careful inspection and it is our opinion that in cases in which it is possible to avoid such crippling conditions with an operative procedure such an operation should be carried out.

When fractures of the tibial condyles are to be considered it is very necessary to subdivide them into three groups. The first and most common group contains those that involve both condyles, the next, those of the lateral condyle, and lastly, those of the medial which are the least frequent. Another factor must be considered and that is that one may have what is actually a double condylar injury yet the cause of the disability and greatest deformity will be in one or the other condyles. When such a condition is found it has been our custom to classify the case as either a medial or lateral condylar fracture depending on the treatment necessary to restore the part to normal.

Quite different problems are encountered in these medial and lateral condyles and they

must be carefully separated when treatment—either conservative or operative—is considered owing to the marked variations in the pathological conditions present. It is for these reasons that we will discuss in this paper injuries only of the lateral condyle. These injuries must be subdivided into five types or groups.

After long continued and careful observation of lateral condylar injuries we are fully aware of the great ability of the knee joint to restore itself to function if given a chance. In some instances in which multiple other injuries have precluded operative attempts at the correction of condylar injuries—although we were certain of the necessity of such a procedure in order to obtain a serviceable limb—we have been surprised at this efficiency. On the other hand in some cases which we have attempted to treat with manipulations and casts—feeling that the injury would not justify an open operation—we have later been forced to correct by incision and elevation of the depressed condylar surface.

As in most other fractures the X-ray pictures cannot be relied upon to tell us with certainty just what should or should not be done. They must be carefully correlated with the deformity and physical findings. It is folly to trust even a provisional diagnosis to anteroposterior and lateral plates, and unless the individual is expert stereorontgenograms will be very misleading. In addition, one must have plates taken at quarter angles anteroposterior and postero-anterior. These six positions when considered with the physical findings will give the surgeon a fair idea of what he may encounter to the joint at the time of operation. We have called attention to some of the incorrect inferences that may be drawn from the roentgenograms in the legends but to impress it firmly requires many more illustrations than space permits in this article.

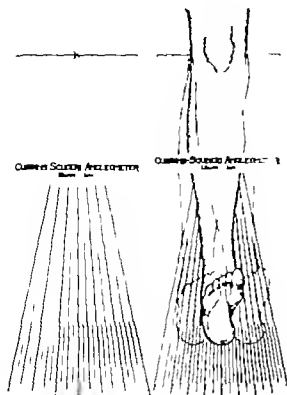


Fig. 1. The leg is placed with the knee at X and the heel over the middle line.

Fig. 2. The knee is held firm and the foot moved laterally and medially to determine the degree of angulation.

The common cause of depressed fractures of the lateral condyle of the tibia is the moving front bumper of an automobile striking a pedestrian upon the lateral surface of the extended leg in the vicinity of the knee joint. It does not make any difference if it is a little above at or below the articulation. It may also be caused by a fall from a height and many other types of violence. This injury to the lateral condyle may be the only lesion present or there may also be an avulsion of the collateral tibial ligament from the femoral condyle (Fig. 13) or what is more rare a rupture of this ligament opposite the articulation. Occasionally such a force may fracture the lateral condyle of the femur or fracture both condyles of the tibia or of the femur or produce a complete dislocation of the knee joint.

SYMPTOMS

The knee joint is always swollen but seldom tender except over the point of bone or liga-

ment injury. If in addition to the bone injury there is a laceration through the synovial lining this spot is also tender. The patella floats, and there may or may not be discoloration. It is not necessary to elicit crepitus. There is always a marked loss of function with some deformity, the deformity being a genu valgum of varying degree. The abnormal mobility is the one symptom that presents unusual phases which must be discussed carefully. In those cases with a fragment of the condyle fractured off or with an even depression of the entire condyle, we find that there is a rather marked valgus and 10 to 30 degrees of lateral motion in the extended leg. In others there will be little if any deformity and a very marked increase in the lateral mobility. Dr. Scuderi designed what we call an angleometer to show the degrees of deviation (Figs. 1 and 2) and by using a scale of this type, the lateral deviation and the abnormal mobility may be determined in the extended limb. However while this method will demonstrate these conditions with the limb in a straight angle, it is of no value when the leg is flexed. If the anterior portion of the condyle remains intact and the posterior portion is crushed there is no increase in the lateral mobility of the extended limb but a marked increase with the limb flexed. If the anterior portion is crushed down leaving the posterior portion intact, there is very little deformity only a slight increase in the lateral mobility of the extended limb but the limb can be slightly hyperextended and the leg rotated inward a small amount. When the posterior portion is depressed (as is seen in Fig. 10) another finding can be elicited which may confuse the examiner—that is, when the leg is flexed 30 to 45 degrees on the thigh and a forward pull is made. The leg rotates forward and inward, just as if the anterior cruciate had been injured. This physical finding is made possible by the fact that the depressed posterior portion of the lateral condyle of the tibia does not impinge upon the condyle of the femur and therefore permits the extra motion of forward and inward rotation. In order to check this finding, the leg must be extended on the thigh and an attempt made to pull it



Fig. 3

Fig. 3 Type 1 Fracture lateral tuberosity—outward displacement—small fragment depressed 1 inch between greater fragments—lateral meniscus displaced down between fragments

Fig. 4 Joint opened—meniscus removed—small fragment elevated—fixed into position with a screw to make a



Fig. 4



Fig. 5

flat arch This screw should have been made somewhat longer

Fig. 5 Type 2 Depressed fracture of the lateral tuberosity Observe that the fragment is displaced laterally but note that cartilaginous bearing surface is depressed obliquely downward and inward The meniscus was fragmented

forward If the anterior cruciate is intact no such motion can be produced.

We are cognizant of the fact that if the anterior cruciate ligament was cut in an experimental effort to find this function, and the other ligaments of the knee joint were left intact no anterior motion would be obtained with a forward pull on the extended leg But in these cases with a force that causes an injury to the anterior cruciate one may rest assured that this anterior cruciate is not the only ligament injured. It is associated with stretching and tearing of many other ligaments.

If there has been simultaneous lesion of the collateral tibial ligament, there will be a point of tenderness and possibly a discoloration at that spot When the collateral tibial ligament is avulsed or ruptured in addition to the crushed lateral condyle lateral motion of the extended leg is always very excessive.

The main points in the pathological anatomy we have stressed in a previous communication but we wish to repeat those findings here and to classify the injuries of the lateral condyle into five types or groups

Type 1 Fracture of the lateral condyle Fragment displaced outward with little if any of the bearing surface depressed (Fig 3 J C)

Type 2 Depressed fracture of the lateral condyle A large fragment displaced outward and the medial portion of the bearing surface depressed obliquely downward and inward (Fig 5, Mr A.)

Type 3 Oblique fracture depression of the bearing surface with only a small portion of the lateral fragment retaining normal level (Fig 7 F J)

Type 4 Fracture depression of posterior portion of the lateral condyle with forward portion intact (Figs. 8 and 9, W J)

Type 5 Fracture depression of the anterior portion of the lateral condyle with posterior portion intact (Fig 14, J F)

The head of the fibula may be fractured in any of the above types except type 5 If the head of the fibula is fractured in a case involving the lateral condyle we may be certain that the posterior surface of the condyle has been depressed The lateral men



Fig. 6

Fig. 6 Meniscus removed—Cartilaginous bearing surface elevated—supported with bone chips from tibia and fastened into a flat arch with wires. This limb should be held adducted with long lateral splint of plaster for 4 to 6 weeks.



Fig. 7

Fig. 7 Type 3 Oblique depression of almost entire bearing surface—meniscus detached and fragmented.



Fig. 8

Fig. 8 Meniscus removed—cartilaginous bearing surface elevated with osteotome and supported with bone chips from same tibia. Must be held in adduction.

meniscus is commonly torn from its lateral attachment and dislocated between the fragments in type 1. It may also be fractured or fragmented in any of the other types described. Small fragments of bone and cartilage are often encountered in the joint fluid and we have expressed several from out of the suprapatellar pouch. The fluid in the joint varies in character with the time that has elapsed between reception of the injury and the operative attack. Early it is bloody and filled with clots; later it is not unlike pus, due to the emulsified fat. Free fat drops commonly float on the top of the fluid and it is remarkable the amount of fat that can be extruded into the joint cavity from a fracture involving only the cancellous bone. The synovia is reddened and discolored by the bloody fluid as well as being swollen and softened. We have not observed any ruptured cruciate ligaments in these cases, but there have been partial avulsions in several (Fig. 14). As a rule, the lateral condyle is fragmented in a depressed fracture—type 1 being the exception. It may be stated here that the

medial condyle is usually fractured off and displaced *en masse*.

TREATMENT

We have encountered about 125 cases of injury of the lateral condyle in the last 6 years and have operated upon about 50. The others have been treated by molding and casts. Only those that we were fairly sure would cause subsequent trouble have been treated with an open operation. In several which we avoided operating upon patients subsequently returned and repair was carried out with good results, although as a rule a late repair is more difficult to make correctly than an early repair and the results are less satisfactory because we are certain that a long continued mechanical insult can cause a chronic arthritis that will seriously prolong the convalescence.

OPERATIONS

These patients have been operated upon under a tourniquet following the expulsion of the excess blood from the limb with an elastic



Fig 9.



Fig 10



Fig 11

Fig 9. Type 4. Postero-anterior view—bearing surface looks fair.

Fig 10. Cartilaginous bearing surface depressed down in a curved line. Lateral fragment and the head of the

fibula fractured and displaced backward and outward.

Fig 11. Postero-anterior view—bearing surface correctly elevated. Apparent genu valgum, but none present in clinical examination.

bandage. Vessels that gape should be sought for, caught and ligated. All patients are carefully tested for bleeding and coagulating time 24 hours before the operative attack. Immediately after and continuing for 6 weeks the coagulation and bleeding time are very low—2 to 3 minutes. Later on a slow coagulating and long bleeding time may be encountered. The wounds have been closed and dressed before the removal of the tourniquet. No secondary hemorrhages have occurred in any of these cases.

An incision paralleling the patellar ligament and extending from well above the patella down onto the head of the tibia has been used. This incision we extend farther down over the tibia when it is necessary to obtain bone chips or pegs for the repair of the injury. We have used a large steel screw, such as is used by carpenters and called a wood screw, whenever we were assured that it would best serve the purpose. The screw has the advantage of not needing a drill or preparation and the deep threads will hold firmly in the cancellous bone even if the screw is not long enough to perforate the opposite cortex, which is preferable. (See Fig 11 where a

perforating screw has been cut off.) In the other cases we have used bone chips and bone pegs with heavy catgut sutures, where it is necessary to have additional support (Figs 6, 10 and 11) but we must discuss the treatment of each type with more detail.

Type 1. A mallet or a redresser may be used in this type and a fair result be obtained, from both a functional and an X-ray view point, but we have found that to remove the meniscus and accurately replace the fragments has been far more satisfactory in that an early mobilization may be started and a perfectly functioning joint obtained. Moderate mobilization may be instituted in 1 week with safety, but one must give the soft tissues time to heal firmly before motion severe enough to cause trauma is instituted.

Type 2 (Fig 5). In this type of case with the bearing surface crushed obliquely down and a fragment dislocated laterally, no amount of pressure or manipulation can restore the cartilage-covered bearing surface to position. The joint must be opened, the meniscus removed in order to see the lesion and the bearing surface freed with an osteotome levered into position, braced with



Fig. 4, left. Lateral view—meniscus removed and cartilaginous bearing surface restored to normal—with bone chips and a screw—flat arch method. Notice defects from which chips were taken. Two years later plates showed edges rounded but defects still present.

Fig. 5. Posterior surface of lateral condyle depressed and fibular head fractured—repaired with oblique plates of bone and catgut suture. Also observe exostosis, caused by a tubercle of collateral tibial ligament.

fragments from the front of the tibia, and the mass fixed firmly like a flat arch with the screw which extends across the tibial head. This limb must be fixed in firm adduction in a cast extending from the trochanter down to and including the foot. Mobilization in such cases must be delayed 4 to 5 weeks, because these small fragments must be given sufficient time to become firm (Fig. 6 Mr. A). If this type of case is operated upon late it is common to find that the meniscus is displaced, fragmented and imbedded in among the fragments of the depressed cartilage with a tough, fibrinous material that makes a fairly even bearing surface.

Type 3 (Fig. 7 F. J.) This type of injury is best repaired 2 to 3 weeks following its occurrence in order to allow the fragmented bearing surface to fuse together so that when the surface is elevated they will not be

scattered all over the joint. The joint is opened, the meniscus removed, an osteotome 1 inch in width used to free the bearing surface around its circumference over to midline, the depressed bearing surface is then elevated and supported with flat plates of bone from the subcutaneous surface of the tibia (Fig. 8). Mobilization may be initiated in 3 to 4 weeks with other physiotherapeutic agents. The possibility of this type of injury being treated conservatively—with a redresser or a mallet—is good, but we are inclined to believe that with these methods there is much more likelihood of displacing small fragments into the joint as free bodies. Another factor is that in those cases of this type on which we have operated, the meniscus has always been detached or fragmented, without the peculiar imbedding in the fragments that we have observed in types 2 and 4, and therefore



Fig. 14, left Type 5 Depression fracture of anterior portion of the lateral condyle bearing surface—with depression—also avulsion of the tibial spine. Fragmentation of meniscus was present.

Fig. 15. Meniscus removed—fragmented depressed bearing surface elevated and supported with chips from same tibia—cruciates in good condition.

may be the cause of much subsequent disability.

Type 4 (Figs 9 and 10) These films show an unusually pronounced depression of the posterior portion of the lateral condyle. This obviously cannot be corrected by any retractor or manipulation. In this case the incision was made just anterior to the collateral fibular ligament the depressed bearing surface levered into position and supported with fragments from the tibial crests and the mass fixed with a screw as shown in Figures 11 and 12. Please note the change in bearing surface and defects in the tibial crest from which the fragments were removed with an osteotome. X-ray films made 2 years later of these tibiae from which fragments have been removed show that the defects are not filled in if the patient had reached maturity at the time of operation. In Figure 13 is seen a depression of the posterior surface that has been elevated and held in place with fragments placed obliquely. It also shows an exostosis where the collateral tibial ligament was avulsed and healed back in position with

out operative treatment. We are convinced that this is the cause of these so-called Pellegrini Stieda disease.

Type 5 (Fig. 14) Here we have a depression of the anterior portion of the bearing surface of the lateral condyle and an injury to the tibial spine, which we repaired by elevation of the joint surface supported with autogenous fragments from the tibia and made firm with a heavy catgut suture (Fig. 15). The cruciate ligaments were firm and were not disturbed. In this type of case the surgeon must not raise the bearing surface too high or there will be a limitation of extension. However this is the only type in which excessive elevation is to be avoided. In the 4 other groups we have been trying to raise the lateral bearing surfaces a little higher than normal to avoid a small amount of genu valgum that will remain unless it is elevated somewhat.

CONCLUSIONS

We wish to emphasize the following:

1. The necessity of multiple roentgenographic views taken from all angles.

2 Careful clinical examination in addition to the X ray views

The results have been excellent. There have not been any severely infected cases. In only 1 case the screw irritated and had to be removed. There have been no completely ankylosed knee joints. In four young colored men the flexion has been limited to 80 degrees, and one white man has a limitation to 50 degrees but he would not permit massage or manipulations of any kind and would not help himself. The aged have developed free flexion and extension more rapidly as a rule than the young men. This is particularly true of the colored men. There are no women in this series.

There has remained a certain amount of genu valgum in most of these cases, irrespective of how perfect the X ray picture has been or how well satisfied we have been with the technique. It is less since we have been elevating the posterior surface a little above normal. This work has been done with steel screws with threads cut up to the head and with ordinary steel screws. The first type is the more satisfactory. We have also repaired these lesions with bone fragments, bone pegs catgut and silk. We never use a foreign body—metal or bone—when we can obtain a satisfactory material whether fascia or bone from the injured limb of the individual whom we are seeking to benefit.

ARGENTAFFINE TUMORS OF THE TERMINAL ILEUM

A CAUSE OF INTESTINAL OBSTRUCTION

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MASSON'S discovery of the silver reducing properties of cytoplasmic granules in the tumor cells of carcinoids has made it possible for him and his co-workers to carry on extensive researches into the origin and development of these tumors. They have given them the name argentaffine tumors and have obtained fairly convincing evidence that these tumors begin with the migration of the Nicholas-Kulchitzky cells from the intestinal mucosa into the neuromata in the wall of the intestine. Raiford recently questioned this mode of development but the work of Masson demonstrates clearly the presence of argentaffine cells inside the nerve fibers. These cells grow very slowly but eventually break through the nerve filaments and invade the surrounding tissue. It seems to us that the only observation lacking is that of actually seeing the living cells as they enter and leave the fibers. Distant metastasis is rare yet the primary growth often obstructs the intestinal lumen and occasionally metastasizes to the regional lymph nodes. At this stage of development these tumors produce clinical pictures similar to the usual carcinomata and may be mistaken even during an exploratory laparotomy for inoperable cancer. Nevertheless many of the recent authors state that these tumors are of no clinical importance and several good reviews of the literature have failed to consider carefully the clinical manifestations of them.

In order that the clinical significance of argentaffine tumors might be better known and that these seemingly inoperable tumors might not be treated as such, we feel that the following case reports should be presented.

CASE REPORTS

CASE 1. T. B., a white woman of 51 years, in January 1931 first experienced abdominal pains which were similar to labor pains and sometimes lasted for several hours but were most intense in the right lower quadrant. Such attacks of pain recurred

at intervals for 1 year during which time the patient became markedly constipated.

Six weeks before admission to the Burlington County Hospital, the abdominal pains became increasingly severe with each succeeding attack yet were not associated with nausea and vomiting. A marked loss of weight had occurred since the onset of symptoms.

The physical examination was negative except for the abdomen which was moderately distended and contained a palpable hard non-tender mass 3.5 centimeters in diameter in the right iliac fossa. The small intestine proximal to the mass could be felt as a sausage-shaped structure in which peristaltic activity was pronounced. The clinicopathologic studies were normal.

Röntgenological studies made by Dr. Borzel revealed an obstructive organic lesion in the terminal ileum which was thought to be of long duration. The colon was normal (Fig. 1).

At operation on February 24, 1932, a small tumor mass was found in the region of the ileocecal valve. This had produced a partial obstruction of the ileum evidenced by the marked dilatation of the lumen and its greatly hypertrophied muscular wall. Several small, hard lymph nodes were felt in the adjacent mesentery. A tentative diagnosis of carcinoma of the ileum with metastases to the regional lymph nodes was made. An extensive resection was done which included the lower ileum, ileocecal valve, cecum and ascending colon and then a lateral anastomosis was made between the transverse colon and terminal ileum. The patient recovered without complications and is now free of abdominal symptoms 23 months later.

Pathology. The gross specimen (S 17714) after fixation consisted of 15 centimeters of the terminal ileum, the cecum with the vermiform appendix, and 15 centimeters of the ascending colon. The angle between the ileum and cecum in the region of the superior ileocecal fold was made very acute by a subserous mass which had drawn the anterior surfaces of the cecum and ileum into close proximity so that the superior ileocecal fossa was obliterated. In the areolar tissue of the mesentery and mesocolon at the ileocecal junction there were four enlarged firm lymph nodes measuring from 8 to 10 millimeters in diameter. The ileum was dilated to a circumference of 6.5 centimeters. Its wall was stiff and the musculature was markedly hypertrophied.

When the lumen of the ileum and cecum was laid open an ulcer measuring 1 by 2 centimeters was found on the postero-inferior surface of the ileum. It extended to within 1 centimeter of the edge of the



Fig. 1. Case T. B. Barium meal fails to pass beyond ileocecal ah. after 24 hours.

lower segment of the cecic valve. The base of the ulcer consisted of a protruding tumor mass of very firm, yellow tissue with a slightly roughened surface. The mucosa at the periphery of the ulcer was not lifted up with resulting overhanging edges, but merged gradually into the tumor. In the mucosa of

the caecum between the left frenalum of the ileocecal valve and the vermiform process was another ulcer 1 centimeter by 1.5 centimeters which was similar to the one described in the ileum. A section through the specimen made so that the two ulcers lay in one plane showed that both were produced by different parts of the same tumor. The cut surface of the tumor had a yellow color, the muscular coats of the ileum and colon were infiltrated so that the muscular layers were thickened and the bundles were separated by strands of tumor. It had also invaded the subserous tissue producing thickening and shortening of the fibrous septa. The lymph nodes contained tumor masses similar in color and consistency to the primary growth (Fig. 2).

The remaining portions of the caecum and ascending colon were normal. The appendix measured 4 centimeters in length and was 1 centimeter in diameter at its middle third. There were no adhesions over the serosal surface. On the anterior aspect of the appendix lying just beneath the peritoneal covering was a small projecting nodule 2 millimeters in diameter. This nodule was firm, had a yellow color on section and was clearly a small tumor lying in the outer muscular coat of the appendix with extension into the subserous areolar tissue. The distal four fifths of the lumen was obliterated by a loose, grayish, translucent fibrous tissue.

Microscopic examination showed that the base of each ulceration was tumor tissue which had also infiltrated the mucosa forming the edges of the ulcer. The line of demarcation was not sharp and in places it was difficult to determine with certainty whether the cells were tumor cells or were epithelial cells forming the intestinal glands (Fig. 3).

The tumor cells were alike in appearance. They were rather small, had poorly defined limiting mem-

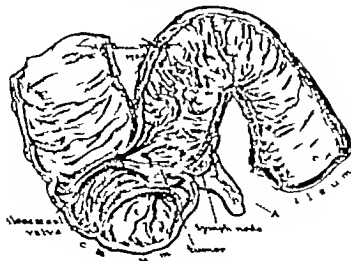


Fig. 2. Drawing of tumor bearing area, Case 1.



Fig. 3 Photomicrograph of section, Case 1

branches and a cytoplasm which was very finely granular and slightly eosinophilic. The nuclei usually had oval outlines, were vesicular with granular chromatic material distributed throughout. In some nuclei a delicate reticular network was present. The cells were arranged in small masses and cords surrounded by narrow strands of connective tissue stroma through which ran thin walled vascular channels. Interspersed through the larger masses of cells were delicate vascular channels composed of little more than the endothelial lining. The tumor cells encircled these vessels so that pseudo-rosettes were formed, but true rosettes were also present in places.

The tumor invaded the muscular layers of the ileum and cecum. At those places the musculature appeared thickened and the tumor was accompanied by much fibromuscular stroma. The subserous areolar tissue was replaced by tumor and the sheaths of the nerves in the intestinal wall were extensively invaded by the tumor cells.

A lymph node in the areolar tissue was practically destroyed by a metastatic tumor mass similar in every respect to that in the ileum (Fig. 4)

Silver stains, carried out according to the technique given by Forbus, demonstrated the argentaffine character of the cytoplasmic granules in the tumor



Fig. 4. Photomicrograph of section showing destruction of lymph node by tumor mass

cells. Most of the cells were filled with these granules but there were scattered groups which contained only small numbers of such granules and an occasional cell had none. Scattered Nicholas-Kulchitzky cells in the intestinal glands were filled with granules which reduced the silver salts.

The small tumor in the appendix lay in the outer longitudinal muscular layer and was confined to this portion of the wall. Its structure was exactly like the tumor in the ileum and cecum, an argentaffine tumor probably independent of the larger one since no evidence could be found to indicate that one was a metastasis from the other. The fibrous tissue obliterating the lumen contained many small blood vessels, moderate numbers of lymphocytes and a few plasma cells. No remnants of mucosa remained and no Nicholas-Kulchitzky cells were in the scar.

CASE 2. M. R., a white woman, aged 53 years, a patient in the Department of Nervous and Mental Diseases of the Pennsylvania Hospital was awakened during the night of February 21, 1932 with acute generalized abdominal pain. A little later she vomited. An effective enema afforded temporary relief but a few days later the abdominal pain recurred and was accompanied by distention, nausea, and vomiting. Attacks of increasing frequency and severity continued but the pains were never localized. She had no hematemesis or melena at



Fig. 5. Case 3. M. R. Penney. In Hospital. Gas and fluid level in the small bowel proximal to obstruction at the ileocecal valve.

any time but she lost 12 pounds in weight during the month from the onset of the symptoms until her transfer to the surgical service of the hospital.

The physical examination was negative except for abdominal distention and active intestinal peristalsis. The clinicopathological studies were normal. Roentgenological examination by Dr. Bishop showed a marked distention of the small intestines with gas together with man fluid levels. The barium enema did not pass the splenic flexure of the colon (Fig. 5).

At operation a hard mass measuring 1.5 centimeters by 1.5 centimeters by 1 centimeter was found, in the wall of the ileum at a point 10 centimeters proximal to the ileocecal valve. It infiltrated the wall so that the lumen was greatly reduced. The ileum proximal to the tumor was dilated and had a thickened wall while the portion 10 centimeters distal to the obstruction appeared normal. An enlarged, firm lymph node was present in the adjacent mesentery. Fifteen centimeters above the primary tumor there was another area of thickening and induration in the wall of the ileum.

A provisional diagnosis of carcinoma of the ileum with metastases to adjacent lymph nodes was made.

An extensive resection was carried out during which a portion of the lower ileum with the enlarged mesenteric lymph nodes, the ileocecal valve, cecum, appendix, and ascending colon were removed. A lateral anastomosis between the terminal ileum and transverse colon was done. The patient recovered

promptly from the operation and has been free of abdominal symptoms for 22 months.

Pathology. The specimen (S. 17581) after fixation, included 40 centimeters of the lower ileum with the ileocecal valve, appendix, cecum and 10 centimeters of the ascending colon. There was, in the wall of the ileum 10 centimeters proximal to the ileocecal valve, a somewhat depressed and puckered area which on palpation was found to overlay a firm tumor mass. This mass measured 1.5 centimeters by 1.5 centimeters by 1 centimeter. It was located in the ventral or anterior portion of the wall of the ileum about 1.5 centimeters from the mesenteric border. The circumference of the intestine was greatly reduced at this level. The ileum above the point of constriction was dilated and had a circumference of 9 centimeters. The wall was firm and the musculature was hypertrophied. The portion of the ileum between the tumor and the ileocecal valve was normal.

A large firm lymph node 1 centimeter in diameter lay in the mesentery in the vicinity of the tumor.

The indurated area which occurred 15 centimeters above the tumor just described proved to be a leiomyoma (Fig. 6).

When the lumen of the ileum and colon was laid open an ulcer measuring 1 centimeter by 1.5 centimeters was seen in the mucosa of the ileum where it overlay the tumor just described. The mucosa forming the edges of the ulcer was not lifted up, but rather merged with the tumor which formed the base of the ulcer. This depressed portion of the tumor had an irregular surface, was of a deep yellow color and was a little roughened by a thin film of exudate which covered it. A cut made through the tumor and enlarged mesenteric lymph node so that the surface lay in the same plane, showed that the dense, yellow tumor tissue had infiltrated the muscular layers of the ileum and was extending out into the subserous fat and that the lymph node was practically replaced by tumor tissue almost precisely like that of the primary growth. No tumor nodules could be found in the appendix.

Microscopic section revealed a tumor composed of rather small cells without very distinct limiting membrane. The nuclei were relatively large, slightly oval in outline, and vesicular in character with chromatin granules lying in the periphery of the nucleus, the central portion being left as a clear zone practically free of chromatin material. Scattered hyperchromatic nuclei were present but no mitotic figures were demonstrated. The cells were arranged in large and small masses in which rosettes and pseudo-rosettes occurred.

The tumor infiltrated the mucosa at the edges of the ulcer so that a sharp transition between these tissues was lacking. The base of the ulcer was composed of tumor tissue in which there was a rather marked inflammatory reaction evidenced by round cell infiltration of the more superficial parts of the tumor and a polymorphonuclear leucocytic exudate covering the ulcerated surface. The tumor cells invaded all of the layers of the intestinal wall but

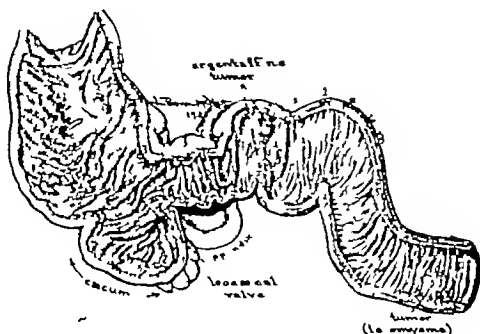


Fig. 6 Drawing of tumor areas in Case 2

the greater portion of the tumor lay in the position previously occupied by the mucosa, submucosa and muscularis mucosae.

The mesenteric lymph node was hardly recognizable due to the replacement of its structure by tumor similar to that described in the wall of the ileum. There was relatively more stroma in the metastasis than in the primary tumor. The stroma cells were small, usually spindle shaped and were compactly arranged in dense bands separating the masses of tumor cells. There was little or nothing to suggest the presence of smooth muscle cells in the metastasis.

Silver stains showed that there were large numbers of argentaffine granules in a great proportion of the tumor cells. The Nicholas-Kulchitzky cells in the intestinal glands were well stained and occurred frequently.

Argentaffine tumors resemble carcinomata in that they invade tissues locally and extend into the regional lymph nodes. They may be differentiated from the usual carcinomata by their yellow color, firm consistency, the absence of necrosis, lack of mitosis in the tumor cells, and the ability of the cytoplasmic granules to reduce silver salts.

Practically all of the cases of metastasizing carcinoids have shown signs and symptoms of mild intestinal obstruction over relatively long periods before the terminal stages of cachexia

and death ensued. Both of our cases presented evidence of rather marked obstruction and had metastases in lymph nodes. Ewell and Jackson's patient had obstructive symptoms without metastases. Their patient underwent operation successfully and was well 2 or more years after extirpation of the tumor. Stewart and Taylor's patient with a carcinoid of the appendix and metastases to the pelvis was well 10 years after removal of the original tumor and metastases.

The excellent results obtained in these cases lead us to feel that it is very important to diagnose argentaffine tumors correctly at operation since removal of the tumors with their metastases offers a highly favorable prognosis.

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SUBTOTAL RESECTION OF THE PANCREAS FOR HYPOGLYCEMIA

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THE recent interest in chronic hypoglycemia as a surgical problem has now in enough cases resulted in the successful removal of an adenoma of the islet tissue of the pancreas with the restoration of the amount of blood sugar to a normal level to include this condition definitely in the group of those affections which are amenable to surgical therapy. A review of the reported cases up to December 1932 has been given in one of our former articles. Since preparing that article adenomata have been removed successfully in 2 more cases at the Barnes Hospital making a total of 5 successful cases at that hospital alone and several other cases have been reported by various authors. It is impossible however to diagnose accurately the presence of an adenoma even when attempts have been made to exclude other causes of the low blood sugar such as a disturbance of the glycogenic function of the liver, a failure of the adrenal glands to secrete the proper amount of adrenalin and disorders of the pituitary. The literature contains records now of several cases in which because no tumor of the pancreas was found at operation a portion of the apparently normal pancreas was removed. For example portions of a normal appearing pancreas have been removed by the Finneys, by Holman and Railsback, by Judd and his collaborators, and by Harris and Taylor. In a recent article Judd, Allan and Rynearson have summarized the experience at the Mayo Clinic in operating on 8 patients for a supposed adenoma of the pancreas. In 4 of these cases, segments of various sizes were removed from the pancreas because of failure to find the expected tumor. The results were not particularly striking in any of their cases and the patients still continued to have hypoglycemia. One of these cases is particularly interesting because it is the patient from whom Holman about 4 years previously had removed about one half of the pancreas because of failure to find an

adenoma. At a later operation performed by Judd only a small nodule was removed from the remaining portion of the pancreas and there was no marked change in the patient's condition. The case had been previously reported by Holman and Railsback as having been slightly improved. Evidently the improvement was not sustained. In the Finneys case approximately two-thirds of the pancreas was removed beginning at the tail. There was no noteworthy improvement in the patient's condition after the operation. In a personal communication Dr. Seale Harris has written that in a patient operated upon by Dr. Adrian Taylor a clinical cure was accomplished by the resection of about half the body and all of the tail of the pancreas except the portion attached to the splenic vessels.

It becomes evident from this brief review of the reported cases that in general the resection of an approximately normal pancreas up to the amount of two-thirds of it is not likely to result in permanent improvement of the chronic hypoglycemia except rarely. Several authors have drawn an analogy between the condition of so called hyperinsulinism with hypoglycemia and hyperthyroidism with its effects. The argument has, therefore, been made that removal of some of the pancreas should have just as much effect in the relief of hypoglycemia as does the removal of part of the thyroid gland in cases of thyrotoxicosis. This idea was originally expressed by Wilder and has since been mentioned by many authors who have written on the subject of the application of surgery to hypoglycemia. If it should prove true that there is such a condition as hyperinsulinism associated with a pancreas which is relatively normal anatomically then it would seem apparent that the removal of a considerable portion of the pancreatic tissue would probably improve the state of hypoglycemia. In line with such reasoning one might suppose that the failure to obtain permanent and satisfactory results

in the majority of cases in which a true tumor has not been found might have been due to the removal of too little pancreatic tissue. It is well known, for example, that it is necessary to remove from the normal dog approximately 80 per cent of the pancreas in order to create a state of diabetes. Likewise it will be recalled that surgery in toxic thyroid disease remained on the whole unsatisfactory until it became generally recognized that it was necessary in most cases to remove nearly all of the thyroid gland.

With these considerations in view the following case seems to be of interest and importance because of several features. Owing to a failure to find a suspected adenoma a subtotal resection of the pancreas was performed in which all of the pancreatic tissue was removed except for a very small portion which was allowed to remain in order to protect the common bile duct. It was estimated that between 80 and 90 per cent of the pancreatic tissue was removed. The result of the removal of this amount of pancreatic tissue was a prompt improvement in the persisting chronic hypoglycæmia, and this improvement has been maintained over a period of 9 months. Another unusual feature about this case is that it is the youngest patient, reported in the literature, who has been subjected to an operation for a supposed adenoma of the pancreas (1 year of age). Apparently also it is the first time that a deliberate attempt has been successfully carried out to remove practically all of the pancreatic tissue. Another striking feature of the case has been that the correction of the state of hypoglycæmia in the patient has permitted the baby to develop from a patient with a markedly retarded mentality to one with a mentality so developed that the parents consider her to be a normal child.

The patient was admitted to the St. Louis Childs Hospital on May 9, 1933, at the age of 13 months because of convulsions. The admitting note was as follows: The baby was a full term spontaneous delivery without difficulty. The birth weight was 9 pounds, perfectly well until the age of 3 months when she had a mild convulsion involving only the arms and chiefly the right arm. At 7 months she had another convulsion which was more severe and began in the right leg with progression to the right arm and right face. Yesterday there was a series of six convulsions mostly on the right side.



Fig. 1. Section of pancreas removed showed no neoplastic growth.

The majority of these convulsions lasted from 2 to 4 minutes but one lasted for nearly an hour. The blood calcium which was determined at the request of Dr. H. W. Gante of Anderson, Indiana, when the patient was 12 months of age was found to be low (4.3 milligrams per 100 cubic centimeters of serum) and since that time she has been taking calcium gluconate by mouth. She has been able to hold her head up slightly since the age of 3 months but she does not sit up, walk or talk.

Examination showed a cheerful, fat, flabby hypotonic baby. The head appeared somewhat larger than normal. The fontanelle was very widely open but not bulging. Four deciduous teeth were present. The reflexes were equal and active. The patient would not hold up her head for more than a very brief moment. On May 12 her fasting blood sugar was 10 milligrams per cent expressed as true glucose. A glucose tolerance test showed a rise of 60 milligrams per cent in 1 hour with a fall of 40 milligrams per cent in 3 hours. Several other determinations of the fasting blood sugar showed a marked hypoglycæmia.

On May 17 Dr. Sidney I. Schwab, after a neurological examination of the baby, made the following note: This is a hypoglycæmic child with convulsions. No neurological basis for the convulsions is found. In the hypoglycæmic state the patient ap-

TABLE I—BLOOD SUGAR VALUES OBSERVED DURING PERIODS OF STUDY AND TREATMENT

Period I (May 9-3) (June) Regular diet—no treatment			Period II (May 22-3) Ins. & carbonyl, diet diet			Period III (June 2-6) Regular diet—primary extracts			Period IV (July and subsequent) Podopneurin		
Date	Hrs. after feed	Glucose mean per 100 c.c.	Date	Hrs. after feed	Glucose mean per 100 c.c.	Date	Hrs. after feed	Glucose mean per 100 c.c.	Date	Hrs. after feed	Glucose mean per 100 c.c.
5-31		†	5-3		47	6-14-3	5	20*	7-4-3	5 P.M.	32†
6-9	4	†	5-5-33		85	6-22-3	4	20	7-10-33	2:55 P.M.	41.5*
6-11			6-			6-2-3		33	7-	3	30.5*
6-11	1		6-		19	6-3-3	5	20	7-3-3	3	7
					7*	6-3-3		33	7-3-3	3	13*
6-		†			206	6-5-33		3	7-3-3	3½	109
6-2-			3		93	6-19-33	3	3	7-12-33		16
6-2-3			7		27	6-2-33		24	7-3-33		120*
6-8		3	8-5		43	6-20-3		25	7-12-33	1½	8
6-33		8*	3		7*	6-20-3	3	3	7-3-33	1½	15*
					66*	6-20-33		25*	7-4-33		16*
6-					20	6-20-33		20*	7-5-33	1	20
			3		10.5	6-3-33	3	10	7-5-33	1½	20*
					63	6-3-33	3½		7-6-33	3	3
			5-17-		24	6-4-33	3	1	7-1-33		39*
						6-12-33	3	1*	7-2-33	3	25*
						7-3-33	4	37	7-2-33	3	27*
						7-6-33	3½	24	7-7-33		32
									8-2-33	3½	20*
									8-20-33	3½	41*
									8-3-33	3	16
									8-23	3½	67*
									8-1-33	3	63
									8-16-33	3	69
									8-26-33	3½	73
									8-26-33	1	77*
									8-3-33	3½	63
									10-3-33	3½	90*
									4-19-34	4	23

*Capillary whole blood true sugar shown
†Venous whole blood apparent sugar shown

appears dull and lethargic and gives the impression of mental deficiency or backwardness. When the blood sugar is near or beyond the normal after feeding of carbohydrates the patient becomes more alert, appears brighter, holds her head up, and can almost sit alone. This would seem to establish in my opinion the relationship between the hypoglycemia and the convulsions and the mental state.

On several occasions in the hospital the patient had convulsive attacks which were sometimes chiefly present on the right side but sometimes also most marked on the left side. In some of the attacks she

apparently became unconscious. Prompt relief was regularly obtained by giving orange juice by gavage.

Before a decision was made to look for a pancreatic tumor the patient was studied from a number of angles. The observations may conveniently be divided into a number of periods as follows (see also Table I).

1 Initial observations. During this first period of study the patient was kept on an ordinary infant diet, suitable for a baby 12 months of age. Dur-

TABLE II—GLUCOSE TOLERANCE TESTS BEFORE AND AFTER OPERATION

Date	Time	Blood sugar mgm per 100 c.c.m.	Remarks
5-12-33 Before operation	12 50 p.m.	0 0	10 0 gm. glucose (75 gm. per kilogram body weight) given in 150 c.c.m. dilute orange juice at 50 p.m.
	1 30 p.m.	30 0	
	3 30 p.m.	41	
	3 30 p.m.	6	
	4 10 p.m.	41 0	
4-30-34 After operation	8 55 a.m.	10 0	7 5 gm. glucose (75 gm. per kilogram body weight) given in 50 c.c.m. dilute orange juice 1 5 p.m.
	9 35 a.m.	80 5	
	5 p.m.	90 4	
	11 05 a.m.	99 4	
	05 p.m.	47 7	

*The apparent discrepancy in the statement here that the body weight was greater on May 12, 1933, with the at present in the text that the child gained 6 pounds between her discharge from the hospital and the examination on April 30, 1934, is to be explained by the fact that there was an actual loss of weight during the child's stay in the hospital because of several infections.

ing this period which lasted a week or so she had several convulsions often seemed very drowsy was rather hypotonic most of the time and generally im- pressed one as being mentally deficient. Routine physical and laboratory examinations revealed nothing of importance except for the blood sugar concentration. The Wassermann and tuberculin reactions were negative. Schick test was positive. The urine was normal the blood count and smear within normal limits. Her serum calcium was 12 0 milligrams per 100 cubic centimeters, serum inorganic phosphorus 5 0, non protein nitrogen 23 0 protein 7 1 per cent. The initial blood sugar however was 45 0 milligrams per 100 cubic centimeters (non true sugar value). The following day it was 13 0 milligrams per 100 cubic centimeters. Two days after admission a glucose tolerance test was made (see Table II). During the next few days blood sugar determinations were repeated and true sugar values on capillary whole blood were usually under 30 0 milligrams per 100 cubic centimeters, and on one occasion the extremely low value of 6 0 milligrams per 100 cubic centimeters was obtained.

2 During this period, the effect of a high carbohydrate diet was studied. In addition to her regular infant diet with milk feedings at 4 hour intervals she was offered in between each milk feeding orange juice with added sugar the idea being to keep up constant absorption of dextrose from the intestinal tract. During this period the blood sugar rose distinctly but in general remained still slightly subnormal. This rise in blood sugar was accompanied by improvement in the appearance of the patient, convulsions ceased she seemed somewhat more alert, she sat up by herself and the nystagmus, which had been present from time to time, remained absent for long periods of time. At the beginning of the study she developed a respiratory tract infection accompanied by fever. Associated with this infection there was a rise in the blood sugar to 230 milligrams per 100 cubic centimeters accompanied by a transient period of glycosuria. After recovery

TABLE III—RESPONSE OF BLOOD SUGAR TO EPINEPHRINE BEFORE OPERATION

Date	Time	Blood sugar mgm per 100 c.c.m.	Remarks
6-30-33	8 50 a.m.	13 0	3 mgms. adrenalin chloride given subcutaneously at 9 00 a.m.
	9 30 a.m.	67 0	
	9 43 a.m.	84 0	
	10 04 a.m.	90 0	
	1 15 p.m.	57 0	
8-10-33	8 50 a.m.	50 0	3 mgms. adrenalin chloride given subcutaneously at 9 55 a.m.
	9 24 a.m.	102 0	
	9 45 a.m.	14	
	06 p.m.	15 0	
	10 35 p.m.	3	
	1 34 a.m.	13 0	

from this infection the blood sugar again returned to a subnormal level.

3 During this period we investigated the effects of several pituitary extracts which were thought might contain substances tending to raise the blood sugar level. Loeb's thyrotropic pituitary hormone was used as well as Collip's thyrotropic pituitary hormone and the growth hormone of Parke Davis and Company. Despite the injection of what presumably was a large amount of such substances, no real effect on the blood sugar level was determined.

4 During this period we investigated the glycogenic function of the liver. Adrenalin was injected subcutaneously and the blood sugar followed for a number of hours afterward (see Table III). Adrenalin was quite effective in bringing the blood sugar up to a normal value and holding it there for several hours. At this stage of the study it was felt that it was extremely advisable to explore the pancreas in the hope of finding a tumor.

On July 10, 1933, the patient was operated on (by E. A. G.) through an upper left paramedian incision. The pancreas was exposed without difficulty through the gastrocolic omentum. Nothing resembling a tumor was seen or felt. Exploration of the rest of the abdomen revealed nothing abnormal. Both adrenal glands were felt to be normal in size. The liver also seemed normal. It was, therefore, decided to resect most of the pancreas. The tail was mobilized easily and it was stripped from the splenic vessels without difficulty except for the ligation of five or six small veins which were tributary to the splenic vein. Almost a complete removal of the pancreas was accomplished leaving only a small remnant of pancreatic tissue in the curve of the duodenum to protect the common bile duct. The amount of pancreas which was allowed to remain was estimated at less than one-eighth of the total amount. The resection of the pancreas was accomplished with surprising ease. A rubber dam drain was placed next to the stump of the pancreas and it was brought out through a stab wound. The incision was closed in layers.

Following the operation the patient developed a blood sugar of 322 milligrams per cent and of course had glycosuria. The hyperglycemia gradually

diminished, and finally a true sugar value which remained fairly constant around 80 milligrams per 100 cubic centimeters (which is normal) was attained. During this time there was some trouble as the result of a wound infection. Persistent otitis media also made it necessary to do a bilateral antrotomy. During her recovery from the wound infection and the mastoid operation she lost most of her flabby fat. During this time her blood sugar remained normal. It seemed to us that she appeared a little bit more intelligent and noticed things about her more. Intelligence tests, however, as conducted by an expert, Miss Barbara Kendall failed to reveal any improvement over several months time. She commented as follows: "Perhaps it is too much to expect a change until the patient is put in a more stimulating environment and until she has fully recovered from the effects of her recent illnesses." The patient was discharged from the hospital on October 22, 1933.

Examination of the pancreas. The removed pancreatic tissue was given immediately to Dr. James L. O'Leary for examination. Dr. O'Leary, of the department of cytology is a former pupil of Dr. R. R. Bensley of the University of Chicago and is familiar with all of Bensley's special methods of examination of the pancreas for secretion granules. Dr. O'Leary's report of his examination follows:

The material received for diagnosis consisted of a portion of the pancreas of a child of 11 months which had been removed by Dr. Ewart Graham and associates 10 minutes previously. It appeared normal to gross inspection, contained no palpable masses.

Blocks were fixed immediately in aqueous, a cetic (5 per cent) and formol (10 per cent) chrome sublimates, in acetic-ormic-bichromate (Bensley's fluid) in formalin-potassium bichromate (Regaud's fluid) and in picro-acetic formal (Bouin's fluid). Several strips were placed immediately in Ringer's fluid and in 1:3000 neutral red in physiological saline for fresh examination.

Islet cells were isolated by teasing bits of fresh pancreatic tissue the bits were mounted between slide and coverslip and studied with an oil immersion lens. The islet cells thus examined in the fresh, unstained state appeared normal. In the material immersed in neutral red it was found that the specific cytoplasmic granules of all islet cells, which had ready access to the dye, colored. No differentiation between A and B cells was apparent.

Five micron sections from the formal chrome sublimate blocks, after dehydration, imbedding and cutting were stained by the Mallory azan method and with aniline acid fuchsin Mallory II. The slides stained by the latter method received a preliminary treatment with potassium permanganate and oxalic acid. Sections from blocks fixed in formalin, a cetic and aqueous chrome sublimates were stained with Bensley's and Bouin's neutral dyes.

"The acinar and duct components of the pancreas may be dismissed with the statement that detailed

examination revealed no abnormal characteristics. A complete survey by the section method of the pancreas removed showed no evidence of neoplastic growth (Fig. 1).

"The appearance of the islets was considered in more detail by comparison with a series of similarly fixed critical specimens. The series included (1) two normal adult pancreases obtained at necropsies performed shortly following accidental death (2) the pancreases of two adult patients having symptoms of chronic hypoglycemia (these were obtained through the courtesy of Dr. Nathan Womack, St. Louis, who removed about one-half of the pancreas in each case with subsequent alleviation of the hypoglycemic symptoms) (3) a case of hypertrophy of the islets of Langerhans in the newborn examined through the courtesy of Dr. S. H. Gray, St. Louis and (4) a series of slides demonstrating hydropic degeneration in the islets of the cat's pancreas during the course of experimental diabetes produced by the removal of seven-eighths of the organ. The latter were representative of the material used by Homans (1914, J. Med. Research 30) in his extensive study of experimentally produced hydropic degeneration. They were loaned to us by Dr. R. R. Bensley.

"As far as could be judged from thin sections, the islets occurred in normal size and number. A, B and D cells occurred in the normal order of frequency. They usually had closely packed specific granules but not infrequently cells were observed which had a sparsity of granules. Occasional cells were found which had pyknotic nuclei and dense cytoplasm containing numerous vacuoles of varying size. These did not resemble those found in the condition called hydropic degeneration.

"In contrast to the portions of the pancreases obtained through the courtesy of Dr. Womack, and critical normal control material, the majority of the islet cells after formal chrome sublimate fixation, contained no vacuoles. In the material used for purposes of comparison normal appearing islet cells of both alpha and beta varieties were frequently found which contained two to three, sometimes five or more small vacuoles scattered through the cytoplasm.

In the islets of the present case there were a slightly larger number of degenerating cells than are usually found in the islets of normal pancreases although it is questionable whether or not this observation has any particular significance."

RE EXAMINATION OF THE PATIENT 9 MONTHS AFTER OPERATION

On April 19, 1934 the patient returned for examination. The mother stated that there had been no convulsions and no repetition of any of the former symptoms of hypoglycemia. The most significant finding in the examination was a true blood sugar value of 83 milligrams per 100 cubic centimeters in the fasting

state a practically normal amount. The remainder of the blood chemical studies showed the following: Serum carbon dioxide content 53.7 volumes per cent, serum protein 8.06 per cent, sodium chloride 620 non protein nitrogen 27.0 and inorganic phosphorus 6.1 milligrams per 100. The baby had developed physically to a gratifying degree. She had lost her flabby appearance, she was able to sit up without difficulty but was still unable to stand without holding to something. Her nutrition was normal. She had sixteen teeth. The fontanelles were closed. The stools were normal and on microscopic examination showed no abnormal deficiency in the digestion of starch or fat. Her weight was 25.5 pounds, a gain of 6 pounds in the 6 months since her discharge from the hospital. The mother felt convinced that the baby was normal mentally for her age of 23 months. She took a marked interest in toys, responded to her name and said three or four words. A re-examination of the patient, however, by Miss Kendall failed to show as much definite evidence of gain in mental development as seemed probable. Her conclusion is as follows: 'The intelligence quotient of 52 represents a gain of 15 points over the rating of 37 (the previous rating) or a gain of 7 months since October. It is impossible to foresee whether a further gain in intelligence quotient is to be expected.'

CONCLUSIONS

A case is reported in which between 80 and 90 per cent of the pancreas was removed from a baby 1 year of age for chronic hypoglycæmia with repeated convulsions and a marked retardation in mental development.

The blood sugar, although at first raised to

an abnormally high level as a result of the removal of so much pancreatic tissue, later became practically normal in amount. All of the symptoms caused by the hypoglycæmia promptly disappeared and have not recurred.

The mental and physical states of the patient have shown marked improvement since the operation, but it is too early to determine whether the mental development of the baby, perhaps retarded by the persistent hypoglycæmia, will progress to the state of a normal child.

The pancreatic tissue which was removed was essentially normal anatomically. It is impossible therefore to state whether the hypoglycæmia in this case was due to hyperinsulinism or to some other factor. The other known causes of hypoglycæmia were apparently satisfactorily excluded.

This case differs from other cases in which portions of apparently normal pancreas were removed for hypoglycæmia in that in this case a much larger proportion of the organ was removed, amounting actually to a subtotal resection.

No interference with the general nutrition of the baby or of the acid base balance of the blood occurred as the result of losing nearly all of the pancreatic tissue.

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PASSIVE VASCULAR EXERCISE IN THE TREATMENT OF PERIPHERAL CIRCULATORY DISEASE¹

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IT is one of the most trite of medical axioms that a man is as old as his arteries. The gradual lessening of blood to the tissues is the mechanism that carries us farther and farther away from the glory of youth.

When this lessening of blood supply takes place very gradually and involves most of the tissues of the body simultaneously we accept it with more or less resignation. It is only when some particular part is involved sharply or when the change in blood supply occurs earlier than the average age expectation that our attention is especially arrested.

That this alteration in blood supply is inevitable and is the cause of the great involution in the body is a part of our common knowledge. We look upon it as one phase of our biological heritage. Why certain tissues are involved out of all proportion to the remainder of the body or why these changes should occur as a pre-senile process, arouses in the student of pathology and therapeutics a curiosity that is on the increase. Through observation and experiment a very great impetus has been given to the study of the etiology of impaired circulation and in recent years much has been written regarding prevention and treatment.

From a surgical standpoint, we are chiefly concerned with the circulation of the extremities—the problems of peripheral circulatory disease—but whatever the structure involved the causes, the damage and the principles of treatment are the same. Coronary thrombosis, interstitial nephritis, atrophic cirrhosis, and anemia of the central nervous system are brothers to peripheral vascular disease. We cannot see these deeper structures so plainly nor can we approach them so easily and that makes the difference.

We have been passing through a phase of active operative therapeutics in the treatment of these conditions. Reversal of the circulation, balancing the circulation, ligation of the main artery, arterial sympathectomy

and ganglionectomy were thought out and courageously tried for there is much to gain and little to lose in fighting for the life of a limb already doomed. In the last analysis amputation is a confession of failure, but it is often a method of relieving the patient's symptoms and sometimes prolongs his life.

At the present time there is a tendency to urge earlier diagnosis and conservative treatment rather than wait until some form of necrosis or infection has occurred. A very considerable literature has accumulated and the authors are stressing a number of factors. The lessening in blood flow is due to two chief causes: spasm and organic narrowing of the vessels. The development of collateral circulation is the means by which improvement in circulation is, for the most part, brought about. Landis and Gibbon have shown by experiment and observation that suction applied to a limb sharply increases the blood supply.

Morton and Scott worked out and standardized a method of estimating the relative parts played by angospasm and organic narrowing of the vessels in this group of peripheral vascular diseases. Their reports have done a great deal in clearing up a field of therapy in which thought and practice were often cloudy and confused. Pearse has recently reported the experiences of the surgical clinic at the University of Rochester with vein ligation as a means of increasing the amount of blood in an extremity.

In this paper we do not propose to discuss the various operative procedures that have been tried and are still being used, but shall confine ourselves to a report of our experiences with passive vascular exercise.

During the past 25 years, and following upon the pioneer work of Lenche, there has been a gradually increasing interest in the study of peripheral vascular disturbances and a broadening conception of the entire field. Attention and thought and trial were quickened by the

¹From the Surgical Clinic of the University of Maryland, Baltimore.

work of Royle and Hunter in 1924. This was particularly true of the sympathetic nervous system, especially in its relation to the control of blood supply and to pain.

Upon the footsteps of this initial enthusiasm and its reaction, and because of so many disappointments, there has gradually developed a more rational evaluation of all therapeutic measures at our command in the treatment of the various disturbances of the peripheral circulation.

Along with this rational evaluation of therapeutic measures there has developed also the better method of treating each case as an individual problem rather than trying to apply a mass rule. Encouraged by some successes and despite many disappointments surgery is beginning to show a resoluteness of purpose that has not before been seen in this particular field.

In 1834 Junod presented to the French Academy of Sciences his experience with the application of "thinned and thickened air" either to the entire body or to a single portion of it. The apparatus used and which was known as Junod's boot, consisted of a glass and copper cylinder or boot shaped to fit the foot and leg. A broad rubber ring was fastened about the extremity to shut off air. A manometer and thermometer were supplied and the boot was attached to a suction syringe and if needed heated vapors were also applied.

At that time the observation was made that "if the atmospheric pressure over an extremity is diminished the skin swells and becomes red and the limb soon increases in circumference. The inflowing blood spreads an unaccustomed warmth in it, the exerted moisture quickly evaporates and deposits on the walls of the cylinder." The work of Junod did not gain wide recognition and was forgotten.

In 1905 August Bier introduced the principle of hyperemia as a therapeutic measure. His work was followed with great interest and his methods, although they were often modified, were widely used. He stated that "if we accept the reactions of the body as useful efforts of nature we must admit that hyperemia is the most widespread of all autocurative agents."

Bier used a glass boot with a cuff of para paper for its attachment. The boot was hooked up to a bicycle pump and the valves changed so as to convert it into a suction pump. He noticed an increase of surface temperature following treatment. Experience taught him that dilatation of a certain area of capillaries is associated with an acceleration of blood current in the concerned area provided the heart action remains the same. He also noted that in the development of collateral circulation by hyperemia, produced by dilatation of the vessels it was the capillaries that played the active rôle. A modification of this method was used by Willy Meyer and Schmeiden and Klaff in disturbances of the circulation of the extremities. Sinkowitz and Gottlieb in 1917 reported excellent results in 4 cases of thrombo-angitis obliterans.

In December 1933 Reid and Herrmann presented before the Southern Surgical Society a preliminary report of the results of a negative pressure environment in the treatment of occlusive peripheral vascular disturbances. The apparatus used was named the pavaex which is an abbreviation for "passive vascular exerciser." It mechanically supplies an alternating negative and positive pressure environment.

In January 1934 Reid (11) presented a more complete and detailed report of its uses in the Matas Vascular Surgery Lecture. Several years ago the same writer in a paper read before the American Surgical Association (10) made a strong plea for early and conservative treatment, and as a result of the excellent work done by Reid and Herrmann a tremendous impetus has been given to the conservative management of peripheral vascular disturbances.

It is on the basis of their work that the following series of cases is presented. First as confirmatory of their results and second with the view of suggesting that such a method has great possibilities as a therapeutic measure not only in thrombo-angitis, arteriosclerosis and the various occlusive diseases but also in ununited fractures, arthritis (atrophic and hypertrophic), frost bite, gangrene and the various circulatory disturbances that result from trauma.

THROMBO-ANGIITIS OBLITERANS

CASE 1. H. J. white, aged 61 years, had had symptoms referable to the left lower extremity for 1 year. The skin surface was glistening with dusky discoloration; the foot and toes were held immobile; there was edema of the entire dorsal surface of the foot and all of the toes; exquisite tenderness was noted. He was unable to stand any form of pressure. No pulsation was obtained in the dorsalis pedis and posterior tibial arteries. Following an intensive course of treatment over a period of 2 months, subjective symptoms disappeared. Along with this there was a gradual subsidence of the edema and discoloration. At the present time 4 months after treatment was begun, there is no recurrence of symptoms.

CASE 2. Y. P. white male, aged 52 years, had had symptoms referable to the right leg for 7 years. A typical history was noted. When the patient was first seen he showed evidence of having developed some compensatory collateral circulation. Following a series of treatments pulsations developed in the posterior tibial artery, and the subjective symptoms disappeared.

CASE 3. M. B. white, male, aged 30 years, had had symptoms referable to the left leg for 3 years. One year previous to the time he was first seen the second toe had been amputated because of dry gangrene. This amputated stump did not heal. When first seen, examination revealed an unhealed amputation stump of the second toe and a perforating ulcer on the plantar surface of the third toe. Because of excruciating pain and inability to rest the patient had entered the hospital for amputation. An interesting observation in this case was that he had considerable edema in the affected foot but without signs of active infection. Treatment was followed first by almost immediate disappearance of pain, then by gradual reduction of swelling, and, after several weeks, by healing of the ulcers.

OBLITERATIVE ARTERIOSCLEROTIC DISEASE

CASE 1. T. M. white male, aged 55 years, had had symptoms in the left leg for 5 years due to obliterative arteriosclerotic disease of the left lower extremity with severe degree of secondary anemia. The latter was treated first. Following improvement passive vascular exercises were started to which he responded rapidly.

CASE 2. F. C. white male, aged 51 years, had an obliterative arteriosclerotic disease of the right foot and leg with several large painful ulcerations. There had been no response over a period of 3 years to any form of therapy. Following passive exercise in conjunction with prescribed conservative therapeutic measures there was complete disappearance of symptoms with healing of the ulcerations.

FROSTBITE GANGRENE

Ritter reported favorable results in the treatment of frostbite gangrene with hot air

He suggested that it was due to the exercising and strengthening of apparently paralyzed vessels. He also stated that stasis hyperemia was also effective due possibly to stimulation or regeneration of injured cells.

CASE 1. J. F., colored male, aged 20 years, gave a history of exposure to cold over a period of 8 hours. He was seen about 4 hours after his initial exposure, at which time examination revealed large vesicles on both the dorsal and palmar surfaces of all of the fingers of the right hand. There was a definite line of discoloration at the junction of the distal and middle phalanges. The entire hand was cold, swollen, and indurated. Normal pulsations were obtained in the radial artery. In addition to the pathological condition in the right hand, the little finger of the left hand was swollen and indurated. The patient's right hand was treated at 6 hour intervals over a period of 43 hours. This was continued for 3 weeks, the frequency of treatments being gradually tapered off. At the end of this time there had been complete desquamation of the outer layer of the skin of all the fingers, with loss of the nails. There was no necrosis of the soft tissues. He has been seen at intervals during the past 3 months, and there is no evidence of tissue destruction. All of the finger nails have regenerated. On the left hand which was untreated, and which by comparison, showed much less evidence of frostbite, necrosis of the distal phalanx of the little finger developed.

CASE 2. H. C. colored, male, aged 34 years, gave a history of exposure to cold over a period of 12 hours, while working on a grain elevator during one of the coldest nights of the year. He was seen within 6 hours of his exposure, at which time examination revealed extensive vesication of all the fingers of both hands. There was a very definite blue black discoloration of the middle and distal ends of the proximal phalanges. In addition both hands were cold, indurated, and considerably swollen. Radial pulsations were apparently normal. He was treated every 6 hours over a period of 73 hours. The frequency of treatments was then gradually decreased. At the end of 2 weeks there had been complete loss of the superficial epithelium over the involved areas, with loss of all the finger nails except the left thumb nail. There was no destruction of soft tissues. He has been seen at frequent intervals over a period of 3 months, and there is no apparent residual change except for loss of pigment.

In addition to these 2 cases 3 other patients were similarly treated with no apparent residual damage except for the loss of pigmentation.

It will be remembered that the past winter was a very cold one and other patients were seen who were not treated by passive vascular

exercise These ran the usual course of frostbite necrosis and in most instances lost varying lengths of their fingers or toes

UNUNITED FRACTURES AND DELAYED UNION

Ambrose Paré was the first to use artificial stasis hyperæmia in insufficient callus for matation In 1875 Nicolodoni described Dumreicher's method for treatment of insufficient callus. He stated "Perhaps we will succeed in reaching our goal if we are able to send a larger quantity of nutritive material to the threatened place If we can still more fill the vessels and if the tissues are in a condition fit to take up the material of which we now have an abundance an artificially produced and permanently maintained hyperæmia *per se* will exercise a powerful stimulus on the tissues and tissue elements, which participate in formation of callus in accordance with the relation of added nutrition to function In 1886 Brum cited 5 cases of insufficient callus formation satisfactorily treated by means of artificial hyperæmia

CASE 1 G H. white, female aged 43 years, had a simple comminuted fracture of the left tibia and fibula, middle third, which 4 months after the initial injury showed but slight evidence of callus formation either clinically or by X ray General examination was entirely negative except for the local pathology Pulsation was present in dorsalis pedis and posterior tibial arteries Wassermann reaction was negative After 5 weeks of treatment there was sufficient callus formation, which was confirmed by the X ray to permit of weight bearing At the end of 7 weeks the patient was permitted to walk without any type of support She has been seen since at 2 week intervals She has firm union and walks normally

CASE 2 J S. white, female, aged 32 years had a fracture of the right radius and ulna at the middle third An open reduction was performed 6 days after the initial injury She was observed over a period of 10 weeks from the time of her injury and showed no evidence of callus formation either clinically or by the X ray No explanation for the failure of callus formation could be found She was given a series of passive vascular exercises, and in 3 weeks there had developed clinical evidence of sufficient callus formation to justify removal of the splints In 5 weeks time patient showed normal bony union clinically and by the X ray

ARTHRITIS

One of the patients with thrombo-angitis obliterans had been having symptoms ref

erable to his joints over a period of 5 years A diagnosis of hypertrophic arthritis had been made When first seen he was complaining of pain and stiffness in the left knee even more bitterly than of the symptoms in the left foot in which thrombo-angitis obliterans was present While placing the rubber collar about his leg and introducing the foot and leg into the boot he complained of severe pain and tenderness in the knee After being treated twice daily over a period of 3 weeks there was noted a marked subsidence of symptoms in the foot and complete disappearance of symptoms referable to the knee Whether this improvement was coincidental or due to circulatory improvement will have to be proved However, another case of hypertrophic arthritis is now under treatment This patient has shown marked amelioration of symptoms.

Concerning arthritis, Pemberton has made the following observations. "The derangement of function which physicians are now able to recognize as constituting a background of the rheumatoid problem is one that has to do probably in several ways with disturbance of the finer blood supply to various parts of the body and apparently more or less in both types of arthritis

'Arthritic persons as a whole, have lower peripheral temperatures than do normal persons because of the decreased blood flow in the tissues concerned The capillary bed is seen to be rather immobile in a state resembling vasoconstriction and unresponsive to those adaptations which changes in the environment imposed on it.'

With these statements of Pemberton's and the observations noted in the 2 cases mentioned the suggestion is made that possibly we may now have available a simple form of treatment that in conjunction with accepted forms of therapy, may prove of great value in the treatment of these particular types of arthritis

Perhaps the most interesting group of cases treated was a small series of 4 patients with disturbances associated with trauma of the forearm In 2 of these the diagnosis was ischemic palsy, in the 2 others there were glossy stiff fingers, with burning pains

Involving the forearm and fingers. There had been no direct trauma to the median nerve unless pressure from tight splints on the lower forearm could produce such an injury. But for the absence of direct median nerve injury the condition resembled causalgia.

CASE 1: T. G. white, male, aged 46 years. Patient sustained a fracture of the left radius and ulna which, after reduction, was immobilized in a plaster cast. The wrist was placed in the goose-neck position and the elbow was included in the cast. Within 24 hours the patient complained of such severe pain that the upper portion of the cast was removed thereby freeing the elbow. There was a tremendous amount of edema in the elbow region, so the remaining portion of the cast was split. The pain and edema persisted to such a degree that 3 days later the cast was removed. He was hospitalized for a period of 6 days during which time the edema subsided. However, he complained of increasing pain in the region of the wrist and in the second and third fingers, as well as numbness of all the fingers with loss of extension and flexion. He was seen by us 3 weeks after his initial injury at which time he was complaining of a severe boring type of pain in the region of the wrist and of the second and third fingers, with inability to sleep. Examination showed the affected arm to be smaller than the good one. It was quite cold on palpation. Pulsation in the radial artery was apparently normal. There was a dusky discoloration, with evidence of definite beginning fibrotic changes in the soft tissues of the forearm and in the elbow region. There was loss of pronation and supination and partial loss of ability to extend and flex the fingers. X-ray examinations showed normal callus formation at the site of the fractures. There was considerable absorption of the carpal bones and of all of the phalanges. Within 48 hours after beginning treatment he had complete relief from pain. Following this relief it was no longer necessary to administer any type of narcotic or analgesia. After being treated for 2 months physiotherapy measures were begun consisting of manipulation, massage and faradic current stimulation. He was able to flex and extend his fingers and wrist and had partial recovery of pronation and supination. Seen 4 months after his initial injury he shows a very little evidence of any permanent damage.

CASE 2: E. S. white, male, aged 38 years. Patient sustained a massive contusion of the right forearm following which splints were applied. Subsequent X-ray was negative for fracture, and the splints were removed at the end of 24 hours. During this time there had developed such a tremendous amount of edema of the forearm accompanied by such excruciating pain that hospitalization was necessary. He was seen by us for the first time 4 weeks after injury. At that time he was complaining of severe pain along the radial side of the hand. Examination showed evidence of fibrosis of the tendons

of the forearm accompanied by loss of ability of pronation and supination, loss of ability to flex the fingers, and loss of ability to extend the fingers except on flexion of the wrist. The hand felt cold on palpation.

Following a series of treatments he had prompt relief of pain. When evidence of improved circulation was discerned he was given physiotherapy treatments consisting of manipulation and faradic stimulation. After 8 weeks of treatment he has almost complete recovery of pronation and supination. There is also recovery of extension and flexion, except for the index finger which shows only partial recovery. The hand feels warm and the patient no longer complains of discomfort.

The last 2 cases in this report were very similar. Both had very painful arms following fracture without evidence of ischemic palsy. The pain and burning resembled that seen in causalgia. The fingers were glazed and stiff; any motion was painful, and most of the forearm and hand motions were limited, especially pronation and supination.

One of these patients was a woman 50 years old who had a Colles' fracture in March, 1933 and 4 months later suffered a fracture through the elbow joint. The symptoms mentioned followed the elbow injury. In this patient there was extensive edema of the dorsal surface of the hand. After treatment was begun there was an early and almost complete disappearance of the burning and pain. There was gradual improvement in the condition of the hand and all motions improved. At the present time there is little disability except weakness which is noticed after the arm has been exercised for some time.

The next patient was a white woman, aged 60 years, who was sent in because there was a faulty reduction of a Colles' fracture, and after removal of the cast there was a great deal of pain and burning in the hand, forearm, and arm. This patient carried the arm in partial elbow flexion and was unwilling to move the entire extremity because of pain. There was muscle and bone atrophy, marked limitation of all motions, and the fingers were stiff, discolored, smooth and painful. She was sent in to have the faulty reduction corrected. It was thought that further trauma would only increase the severity of her discomfort and disability so that, in spite of the deformity at the wrist, this patient was treated by passive vascular exercise. The result was very prompt and most striking. Pain ceased after a few treatments and the arm and forearm movements rapidly returned. She began to flex and extend her fingers at the end of a week, and after 6 weeks of intensive treatment the only serious residual damage was the deformity due to the unreduced Colles' fracture.

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SURGICAL LIMITATIONS IN THE TREATMENT OF ACUTE SUPPURATIVE PERITONITIS¹

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THE literature of acute peritonitis both American and foreign is greater than that devoted to any other surgical condition, yet the high mortality of acute spreading peritonitis accompanying such lesions as suppurative appendicitis postoperative contamination and leakage and peptic perforation forces the recognition that very extensive experimental and clinical study has suggested no satisfactory operative attack. For approximately 50 years method has succeeded method in the surgery of peritonitis. As we review the various types of treatment that have been applied over this period it becomes evident that our surgical indications and treatment have not been governed by the pathological physiology of the peritoneum. Thus we know that drainage with no matter what type of drain in the presence of unencapsulated and advancing suppuration results promptly in fistulization, that postural methods based originally on anatomical misconceptions do not materially lessen toxæmia or improve prognosis, that lavage and irrigation with irritants antiseptics and hypertonic solutions not only fail to limit infection and to lessen spread but actually accomplish the reverse that enterostomy seldom effects more than the deflation of a distended loop and does very little for a paralytic ileus which in turn has little to do with the mechanism of death that in the presence of actual suppuration spinal anesthesia is likewise ineffective in the control of ileus that fistulizing the thoracic duct

merely causes fatal dehydration and does not lessen toxæmia, that the increasing advance of suppuration responds neither to blood transfusion nor to the restoration of depleted blood chemistry. But it must also be admitted that treatment based upon an intelligent respect for the physiology of the peritoneum, has made little improvement in the mortality statistics. It is our purpose in this discussion to indicate what appear to be certain basic errors in the clinical appraisal and pathological diagnosis of acute peritonitis in the light of experimental and clinical observation and to suggest what surgical limitations are imposed in the management of this disease. A résumé of accepted facts on the pathological physiology of this disease will bear repetition.

PATHOLOGICAL PHYSIOLOGY

Two functions of the peritoneum are of major importance absorption and exudation. Starling and Tubby, Dandy and Rowntree, Clairmont and Haberer, Reschke, Kuhn, Hertzler and many others have built up this knowledge for us. A consensus of opinion from the experimental standpoint indicates that there is active absorption from all parts of the peritoneum visceral parietal the omentum, the cul-de-sac, and the diaphragm, that the open channels or stomata, described by von Recklinghausen in 1863 do not exist. Starling and Tubby found that dyes injected intraperitoneally appeared in the blood before they did in the thoracic duct. Dandy

and Rowntree cannulized the thoracic duct and urinary bladder and showed the chief avenue of absorption of isotonic fluids was the blood vessels that absorption was equal in all postures excepting pelvis down. In which position they found absorption increased 15 per cent—a fact for which they could give no explanation. They found phenolsulphonephthalein in the urine 4 minutes after intraperitoneal injection and found that ligation of the thoracic duct did not modify the time of appearance in the urine. It is known that crystalloids are absorbed more rapidly than colloids. This is particularly true of albuminous fluids of which pus is an example. Albuminous substances and suspensions of particulate matter while slow in absorption are also absorbed through the peritoneal lymphatics which in turn drain into the abdominal lymphatic glands and not into the thoracic duct. Costain attributing the major rôle of absorption to the lymphatics suggested lymphaticostomy but the thoracic duct is primarily a collecting duct for lacteals. Toxic absorption is greater in the normal peritoneum than in the inflamed membrane and the absorption of albuminous fluids is more modified by inflammation than is the absorption of crystalloid solutions. Absorption is increased by peristalsis and to some extent by heat although the latter statement is a debatable point. Under conditions of inflammation absorption is greater when the exudate is thin in consistency and small in volume. Bulky exudates tax the absorptive capacity of the peritoneum and markedly slow the rate of absorption on the third or fourth day of the disease as can be demonstrated by intraperitoneal injections of hypertonic dextrose solution in a dog with diffuse peritonitis.

Absorption is diminished by hypertonic solutions by cold by such substances as glycerin olive oil collodion, adrenalin and acetic fluid. It is also diminished by distention and by fibrin. The function of fibrin in slowing absorption explains the subsidence of toxic reaction in the presence of localization. Even crystalloids are slowly absorbed from fibrin-coated peritoneum. This would seem to suggest the association of virulent infection

and watery thin exudates. Experimentally we (2) noted that the streptococcus usually predominates in such exudates. The rate of absorption is markedly diminished in the later stages of a peritonitis, notably after the third or fourth day.

The typical peritoneal response to inflammation is exudation normally serous, peritoneal secretion rapidly shows fibrin in the presence of irritation. Yates stated that relative encapsulation of a drain was immediate. In an experimental study we (2) were able to demonstrate fibrin in the presence of a drain within an hour and to prevent its formation under the same conditions for 72 hours by the repeated intraperitoneal injections of hypertonic (20 per cent) dextrose solution. Experimental and clinical observation has shown that the maximum fibrin formation occurs in the presence of moderate degrees of inflammation and that it may be completely absent in the presence of virulent infection such as is produced by the streptococcus. We were able to show experimentally that while virulent infections may not evoke fibrin formation that a foreign body such as a drain, always will. Cubbins, in an experimental study of the normal peritoneum showed that no substance however bland or sterile could be introduced without evoking fibrin masses that sterile vaseline was as provocative of adhesions as tincture of iodine.

In an interesting experimental study on the mechanism of death in diffuse peritonitis, Steinberg concludes that death is caused by toxins from bacteria in the peritoneum that intestinal paralysis, stasis, and bacteria play no part. With the idea of slowing resorption Kuhn injected 50 per cent dextrose solution intraperitoneally in amounts equal to 1 per cent of the body weight in both dogs and in man. He overlooked the fact that the marked dilution of the inflammatory exudate resulting thereby materially lessened or prevented the formation of fibrin the most important single factor inhibiting or at least lessening absorption. In our own experimental work, we found that intraperitoneal injection of hypertonic dextrose solution in dogs suffering from diffuse peritonitis shortened the life expectancy of the animal by 50 per cent. We also

noted that the active absorptive capacity of the peritoneum was maintained, as was shown by the disappearance of sugar from the exudate at autopsy. It was also our observation that hypertonic dextrose solution markedly increased the rate of diffusion of infection.

RELATION OF CLINICAL PICTURE TO PATHOLOGY

That there is frequently a basic error in the clinical appraisal and pathological diagnosis especially in cases of acute spreading and acute diffuse peritonitis is evident from a study of clinical reports on cures of so called "general" peritonitis. The clinical signs by which we diagnose an advancing infection of the peritoneum will usually not serve to define its extent. At operation we are rarely justified in attempting to determine the extent of infection by exposing and exploring uninvolved portions of the abdomen. Experimentally, we have found a copious exudate forced probably by peristalsis to regions showing no gross inflammatory changes, a fact that has led us to believe that gravity is not a major factor in the extension of the disease. Tenderness in the abdominal wall extends far beyond the actual zone of involvement in spreading peritonitis; this is commonly responsible for error in judging the extent of peritoneal involvement. In a localized process the zone of tenderness extends very little beyond the actual border of peritoneal involvement. Clinically we have drained an abscess 3 weeks after perforation of a peptic ulcer that occupied a large part of the left sagittal half of the peritoneum, so extensive in size as to crowd much of the small bowel through the right half of the abdomen. Two liters of pus was removed from this abscess yet in spite of extensive involvement the picture was essentially that of abscess and not of spreading infection.

A differential diagnosis between a localizing and a diffuse process is more readily made than between a diffuse process and a generalized one. The markedly lessened toxic reaction that accompanies fibrin mobilization, the usual absence of ileus and a more sharply demarcated zone of tenderness are differentiating features. Ileus, thready pulse and vomit

ing are associated with a diffusing process. Those patients who recover from such a clinical course are often classified as recoveries from general peritonitis. In our opinion, the term "general peritonitis" is a misnomer and in most instances should be restricted to patients who are moribund or who obviously cannot recover.

DRAINAGE

In considering the problems involved in peritoneal drainage the point that is frequently lost sight of is the difference in the reaction to drains of the diffuse and localized types of infection. Writers far too numerous to quote have shown the inefficacy of drainage in spreading and diffuse peritonitis. It is necessary to emphasize however that peritoneal abscess always requires drainage. The reason for this fact lies in the fundamental pathological difference between an abscess and a spreading infection. The peritoneal surfaces that make up an abscess have lost the power of movement, and are covered with fibrin, are edematous and more or less inelastic. The capacity for encapsulation has been lost by previous plastic fixation and proper drainage material not only functions as such but serves to prevent reaccumulation. We have noted in experimental animals that fibrin does not cling to a drain inserted into an abscess. It may plug the opening or fenestrations in a tube, but the latter will not fistulize unless left in until granulations cover it. This statement holds true regardless of the size of the abscess because the functions of exudation and absorption virtually cease in the presence of a well defined deposit of fibrin.

In the light of definite experimental and clinical data discussed here it should be easy to dispose of the problem of drainage in diffuse peritonitis by stating that this condition should never be subjected to drains. If we are dealing with an unquestioned diffuse process in which the small bowel and omentum can be observed without undue handling to be mobile we can definitely omit drainage. But within the limits of some incisions this cannot always be determined with certainty since encapsulation about a septic focus may precede pus accumulation. We believe that an area of definite encapsulation even though

there be no purulent accumulation in the encapsulated area, should be regarded as a potential abscess and drained. On the other hand too frequently unencapsulated accumulations of pus are regarded as local processes and drained. A typical example of such an error is that of a phlegmonous appendix accompanied by the gravitation of unencapsulated pus into the pelvis or a spreading infection accompanying such an appendix, in which a copious purulent exudate wells up between loops of freely mobile small bowel. It was for such a condition that surgeons of a generation ago made multiple stab wounds and put rubber tubes or gauze strips into each wound.

In experimental animals we have been impressed not so much by the inefficacy of drains lying between mobile loops of small bowel as by the actual serious damage resulting therefrom. First of all it is utterly impossible in a patient to determine the patency of a drain. Perhaps gauze is an exception to this statement because the meshes throughout its contact with peritoneal surfaces always fill with fibrin and granulations but a drain of rubber tissue the ideal type for use in contact with the peritoneum may appear and feel to be free and unencapsulated. The fallacy of such a supposition is shown in the experimental animal where it can be demonstrated that only partial encapsulation is the rule but that this encapsulation even if slight nullifies the function of the drain. In this connection it is interesting to note that openings and fenestrations in rubber tubes become more quickly adherent and plugged than do the walls of the tube. This is particularly true if the tube should lie in the vicinity of untached omentum.

It has been our observation at autopsies upon patients who had died from widespread peritonitis within a few hours to a day or so after a last desperate attempt had been made to save them by hasty incision and drainage that there was encapsulation of the drain and not about the septic focus. Duplicating such conditions in dogs we found that in animals within 6 hours of death in one instance 2 hours, where no agglutination of loops or omentum had occurred the drain was suffi-

ciently encapsulated to prevent its functioning as such. We saw this sufficiently often to feel that the peritoneum is at all times more capable of isolating a drain than an inflammatory focus. The more fibrinous the exudate paradoxical as it may seem the less likely will there be encapsulation of the drain. The most striking experimental proof of this statement is the prompt encapsulation of a soft rubber drain in a copious watery thin and virtually fibrin free exudate.

Experimentally the damage most uniformly evoked by drainage is residual abscess. The reason for residual abscess about a drain is that richness of fibrin deposit about a foreign body produces conditions favorable to purulent accumulations. Furthermore when a drain was inserted in such a way as to cross a zone of spread into unaffected loops, the latter became more rapidly involved by the inflammatory process than any other area. From clinical observation we are inclined to believe that a residual abscess forming as the result of a drain is less likely to disappear spontaneously than such an abscess as forms in the absence of a drain. The gradual absorption of an abscess in an unopened abdomen is an example of the latter condition. It seems likely that pus accumulations, when encapsulated may remain for a far greater length of time than we suspect. We have found pus in the peritoneum of apparently healthy dogs as long as 100 days.

Exudates that form rapidly are accompanied by rapid toxin absorption. The increased capacity of the peritoneum for absorption in the early stage of the disease has been mentioned. It would seem, therefore that the removal of such exudate at the time of operation is important. When large accumulations of exudate are present such as occur in peptic perforation and in diffuse suppuration following gangrenous or phlegmonous appendicitis, the removal of the major part of the exudate undoubtedly lessens toxic reaction and also lessens the tendency to residual abscess formation.

A large accumulation of exudate will often be found above the liver in peptic perforation and will pour out when the liver is depressed by the hand. In some instances postopera-

tive subphrenic abscess can be traced to such an overlooked accumulation. Pelvic abscess following drainage of diffuse appendiceal peritonitis has been observed many times a week or more after the removal of a drain.

SURGICAL LIMITATIONS

It would seem from the foregoing that the operative therapy of spreading peritonitis is limited to the removal or closure of a septic focus, aspiration of the exudate and closure of the peritoneum without drainage. It is of course, necessary that the abdominal wound above the serosa be drained. In our experimental peritonitis we (3) produced a so called lethal standard of diffuse peritonitis by means of an open loop of ileum that had a mortality of 90 per cent with a life expectancy averaging 4 days. When we removed the septic loop at the end of 24 hours the mortality was reduced to 58 per cent. This was a severe test because we were dealing with a perforative peritonitis from the terminal ileum. The two closest analogies to this experimental situation are progressive diffuse appendiceal peritonitis and leakage from an intestinal suture line. An appendix is occasionally permitted to "cool off" before operative attack. We believe that only a subsiding abscess should so be left alone and only so long as the abdomen temperature and pulse suggest definite localization. At any time during the stage of spread or advance the appendix, as a source of contamination should be removed. It has been argued that operation during a spreading peritonitis increases the rate of spread and the area of contamination. Both our experimental and clinical observations are opposed to this opinion.

Postoperative spreading peritonitis particularly when the source is the intestinal tract is nearly always a catastrophe yet there is both justification and indication to invade the operative field early in the event of serious soiling. The obvious difficulty of course is that of diagnosis. While all postoperative distention or ilcus accompanied by nausea and vomiting indicates peritoneal reaction when a mounting temperature and particularly a rapidly mounting and persistently high pulse are present we believe it preferable promptly

to re-open the abdomen rather than to wait. It does not require a general peritonitis or even a widespread lesion to cause death. It is obvious therefore that prompt differentiation between serious soiling with infection and ileus without gross soiling must be made.

Quite in contrast to the line of attack in postoperative diffuse peritonitis are the indications in postoperative peritoneal abscess. It is seldom advisable to attack the abscess until it is of sufficient size to assure both complete walling off and indications of its location and parietal relationships. Notable exceptions are the subphrenic and pelvic abscesses.

Experimental workers are familiar with the fact that dogs will frequently show no discernible reaction to the intraperitoneal injections of cultures or suspensions of living pathogenic organisms such as the colon bacillus, staphylococcus and streptococcus. On the other hand, a freshly localizing infection possesses a particular virulence for the uninvolved peritoneum. The inexperienced and unskilled finger has produced many deaths in such situations and if there is any one fact that will bear repetition it is that fresh fibrous adhesions should be regarded as inviolate. The shortest extraperitoneal route must be made the drainage pathway, for example by making a muscle splitting incision close to the spine of the ilium a pus distended appendix can be delivered from a walled off abscess without the prolapse of a loop of small bowel, an accident that may spell disaster. Since seldom does small bowel make up the wall of an appendiceal abscess its presence in the field in such a condition should be regarded as a technical accident. A pelvic gravitation abscess impinging upon the rectum can be drained, with far greater safety rectally than by pushing the finger along the old drainage tract. A subphrenic abscess to the right of the falciform ligament as most of them fortunately are, can be drained extraperitoneally by the very satisfactory method suggested by Nathan and Ochsner.

Several times we have found that X ray films offer considerable help in demonstrating residual abscess in atypical locations such for instance, as the left subdiaphragmatic

area between the ascending colon and the abdominal wall and between the omentum and the anterior abdominal wall. When such abscesses can be so accurately located direct extraperitoneal attack is simplified.

SUMMARY

We are omitting from consideration details of non-operative treatment of diffuse peritonitis such as maintenance of fluid balance of blood chlorides and sugar gastro-intestinal decompression with the Levine tube etc. The latter procedures are of course extremely important phases of treatment and in fact in many instances represent the only treatment applicable. But we also believe that operative therapy in spreading or diffuse lesions is limited to removal of the source of infection be it a suppurating appendix or a leaking suture line in bowel. We also believe that early operative attack during the stage of attack is better than so called conservative management that aims by immobilization and non-interference to promote localization. Lastly aspiration of accumulations of exudate is an important factor in diminishing the immediate toxic reaction and in lessening the tendency to residual abscess formation.

CONCLUSIONS

All methods of direct surgical attack upon suppurative spreading peritonitis, based upon alteration of or interference with the functions of absorption and exudation tend to increase the mortality.

Drains function in localized peritoneal abscesses but in spreading processes, not only encapsulate regardless of the consistency of the exudate but also provoke residual abscess and increase the diffusion of the infection.

In the stage of spreading or diffuse peritonitis removal of a septic focus, such as an ap-

pendix, or closure of a postoperative leakage, followed by aspiration of the major portion of the exudate represents the surgical limitations in the treatment of this disease.

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THE TREATMENT OF CARCINOMA AT THE RECTOSIGMOID JUNCTION BY OBSTRUCTION RESECTION

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MANY variable factors influence to a marked degree the treatment of carcinoma at the rectosigmoid. It is generally accepted that in obstruction of the bowel, which occurs relatively early in cancer at this site relief of the obstruction should precede any operative attack on the lesion. The general condition of the patient particularly cardiovascular efficiency obesity the length of the mesentery of the sigmoid the involvement of the lymphatics by carcinoma, the size of the tumor other pelvic pathology as pelvic adhesions from diverticulitis and the individual preference of the surgeon for one type of operation or another all lead to varying technical procedures.

The aim of all radical operations for cancer obviously demands not only the adequate removal of the growth but also the regional lymphatics which drain the involved region. The lymphatics of the rectosigmoid drain into intermediate nodes in the mesentery but also directly as well as indirectly to the nodes along the inferior mesenteric artery which in turn drain into the lumbar nodes along the aorta. In general, the lymphatic drainage is upward. Villemain Huard and Montague after a study of the lymphatics of this region by the injection method of Gerota believe, that the portion of the rectum above the third valve of Houston is essentially upward. The involvement of lymphatics by pathological processes however may not entirely correspond to the findings obtained by injection methods and therefore the communication of the lymphatics from the rectosigmoid with those of the upper rectum is possible and most surgical procedures have been based on the necessity of resecting the entire rectum with its lymphatics when the rectosigmoid is involved in carcinoma. This procedure is sound and radical and implies the division of the inferior mesenteric artery below the first sigmoid branch with a removal of all of the lymphatics along that artery as well as

the lymph nodes in the mesentery of the rectosigmoid and rectum. A permanent end colostomy is necessary. Of these operations the one stage abdominal perineal operation championed especially by Miles Schmieden and Jones is the most radical and answers all of the indications. The only objections are due to the contra indications for its use in very fat patients or in those whose general condition would not justify the risk. This factor is somewhat personal depending largely on the experience of the surgeon and his judgment as to what risk he can reasonably take.

For those patients not suited for various reasons to the one stage procedure a number of variations of the two stage abdominal perineal procedure have been suggested. The operation suggested by Daniel Jones has much to recommend it (Fig 1). At the first stage the lower sigmoid rectosigmoid, and rectum are freely mobilized by division of the peritoneum on the lateral and medial sides and between the rectum and bladder. The rectum is separated from the bladder and bellow of the sacrum down to the sacrococcygeal junction. This posterior dissection is behind the superior haemorrhoidal vessels which are not divided. The inferior mesenteric artery is divided high up below the first sigmoid branch which allows the circulation of the bowel to be carried on through the anastomotic loops between the sigmoid and haemorrhoidal arteries. Flaps of peritoneum from the cul-de sac and broad ligaments are formed and the tumor is extraperitonealized. A loop colostomy is made in the midline incision or through a separate incision. At the second stage the bowel is removed extraperitoneally from below. The advantage of this operation is its radicality without the necessity of opening the bowel at the first operation. The disadvantage would be the possible insufficiency of collateral circulation with death of some part of the bowel and consequent infection.

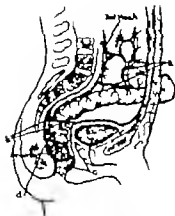


Fig 1. Jones two stage procedure. At first stage mobilization above. Ligation of inferior mesenteric artery below first sigmoid branch. Extrapentonealization of growth. Mobilization of pelvic peritoneum and suture of 1 wall above growth. At second stage removal of rectum from below. (Courtesy Dr Frank H. Lahey Surg. Grace & Ochs November 1930.)

Other multiple stage operations have been proposed where the bowel is divided at the first operation. After mobilization of the bowel Coffey ligates and divides the inferior mesenteric, divides the bowel above the growth and telescopes the closed end of the distal segment through the tumor until it may be pulled out of the anus. An end colostomy is made with the proximal end of the divided bowel. The distal segment containing the tumor is extrapentonealized by suture of the peritoneum of the cul-de-sac so that a tube may be placed extrapentoneally through the lower end of the abdominal incision to the lower segment of bowel. The disadvantages of this operation are the inability to telescope the distal end of the bowel through the narrowed lumen of the bowel at the site of the tumor and the serious danger of pelvic cellulitis from death of the lower segment before the second stage of the operation is performed from below.

Another two stage procedure has been proposed by Rankin (Fig 2). He divides the sigmoid above the growth, closes the distal end of the bowel and drops it back without dividing the blood supply to the bowel. The proximal end is used for an end colostomy. At the second stage, the rectum is freed from below, is surrounded by a sterile glove and then the abdomen is opened and the abdom-

inal portion of the operation is carried out with freeing and removal of the abdominal portion of the bowel and reformation of the pelvic peritoneal floor. The advantage of not opening the bowel at the second stage is obvious but the magnitude of the second operation is still great. Some risk also exists of leakage from the closed distal loop dropped back into the peritoneum. I have lost a patient from such leakage.

In 1930 Lahey proposed another procedure based on the division of the bowel and mesentery above the tumor after its free mobilization but without division of the inferior mesenteric and haemorrhoidal arteries. The end of the distal loop is brought out through the lower end of the abdominal incision and the clamp closing the bowel subsequently released so that between stages the lower segment containing the tumor can be irrigated and cleansed (Fig 3). The proximal cut end of the bowel is brought out through a left muscle splitting incision for a permanent colostomy. At the second stage the open end of the distal stump is mobilized and closed. A laparotomy is performed and an abdominoperineal resection is carried out. The advantages are the wait between the first and second stages with proper preparation of the distal loop by irrigation and the lack of danger of infection of the peritoneum. The operation is hard to do in fat people with a short mesorectum and has the disadvantage of a difficult second stage operation.

I should like to propose and describe another operation for carcinoma at the recto-sigmoid less radical and therefore suitable for use in a limited number of patients but having the advantage of removal of the growth and adjacent lymphatics with final restoration of continuity of the bowel. This operation is applicable to certain cases where the growth is small and where after dividing the lateral and medial peritoneal layers and coming on to the vessels and lymphatics in the mesentery no lymphatic glands are palpated along the inferior mesenteric artery and if any are felt in the mesentery of the bowel they are adjacent to the growth itself. This situation, as far as growth and glandular involvement are concerned may occur in a patient who is in

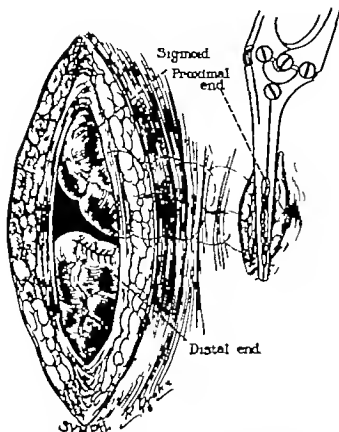


Fig. 2 Rankin two stage resection of rectosigmoid. At first stage the sigmoid is divided above the growth, the distal end closed and dropped back into the peritoneum without dividing the blood supply. (Courtesy Dr. Fred W. Rankin, *Surg. Gynec. & Obst.* November 1931)

no fit general condition to have an abdomino-perineal operation in stages or may be in a patient who flatly refuses to have a permanent colostomy. There are also a limited number of cases in which it is not certain whether the lesion at the rectosigmoid is benign or malignant. It is therefore under this unusual set of conditions that the operation to be described is indicated. Not only are the indications for the operation limited for reasons just enumerated but also on anatomical grounds and it is my feeling before a definite type of operation is decided upon that the local pathology and anatomical relations must be carefully determined.

Assuming that in Trendelenburg position a midline or left pararectus incision has been made and the lesion disclosed at the rectosigmoid the left leaf of the mesentery of the sigmoid and rectum is opened and the incision carried forward at the lower end of the cul-de-sac between the bladder and rectum to join

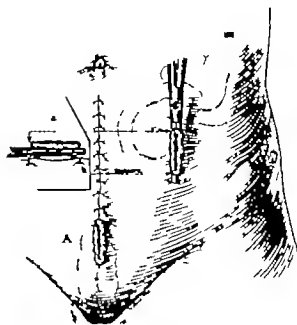


Fig. 3 Labey two stage resection of rectosigmoid. At first stage the bowel and its mesentery are divided above the growth. The proximal end of the bowel is used for an end colostomy. The cut distal end of the bowel is brought out through the lower end of the abdominal incision. (Courtesy Dr. Frank H. Labey *Surg. Gynec. & Obst.*, November 1930)

another incision through the peritoneum on the medial surface of the mesosigmoid and mesorectum (Fig. 4 a). The bowel is now pulled toward the median line marked by mobilizing the bowel at this site, and the medial incision in the mesosigmoid and mesorectum is opened by blunt dissection so that the vessels and lymphatics come plainly into view. If there is no suspicious involvement of the glands along the inferior mesenteric artery and the liver is free from metastases a further effort may be made to determine whether resection is feasible with eventual establishment of continuity of the bowel. The rectum is next freed from the bladder and its lateral attachments by blunt dissection. The hand is then slipped beneath the bowel behind the superior haemorrhoidal vessels and the rectum carefully freed from the hollow of the sacrum. After these maneuvers have been carried out it is now possible in suitable cases to lift the bowel containing the growth well out of the pelvis for about 3 to 4 inches higher than its former position and in so doing it will be seen that the bowel will be devoid of peritoneum in the depth of the cul-de-sac for a distance of 3 to 4 inches in length. If we

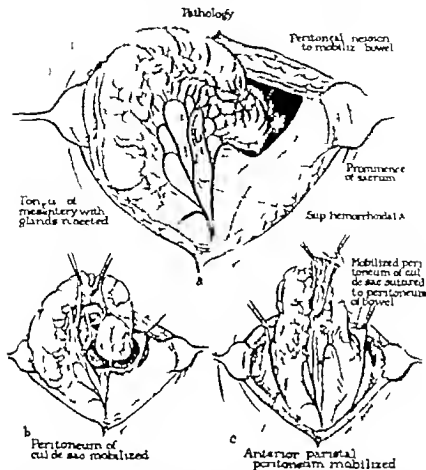


Fig. 4. Proposed resection of rectosigmoid. a, Sigmoid and rectum isolated but cutting lateral and median peritoneal attachment of bowel. b, Triangle of mesentery of rectosigmoid lifted up with bowel. Rectum freed from hollow of sacrum, bladder and prostate. Superior hemorrhoidal artery not divided. Pelvic peritoneum freely mobilized. c, Rectosigmoid now can be lifted out of abdomen. Mobilized peritoneum of cul de sac and pelvis elevated and sutured to bowel. Effect is to eliminate cul de sac. Anterior parietal peritoneum mobilized.

proceed with the operation in mind it will be necessary (1) to remove the growth with the mesorectum and arteries in the arcade supplying it, down to but not including the inferior mesenteric and superior hemorrhoidal arteries (Fig. 4 b) (2) to have left 2 to 3 inches of peritonealized bowel beneath the proposed site of resection (3) to cover the denuded deperitonealized bowel in the depth of the cul-de-sac (Fig. 4 c) and (4) to have a large enough sigmoid loop to swing around and sew to the peritoneum covered rectum for a future anastomosis between the two portions of bowel. If any of these postulates

are not feasible of performance the procedure under discussion should be abandoned. If conditions are favorable it is very easy to raise the peritoneum on either side of the cul-de-sac and sew it to a higher level on to the peritoneum of the rectum (Fig. 4 c). This practically obliterates the cul-de-sac and peritonealizes that portion of the bowel which has been drawn upward into the abdomen from below the cul-de-sac. The mesentery of the bowel about to be resected is divided in the usual way the apex of the resection being slightly above the promontory of the sacrum. A site of resection on the

sigmoid loop is then selected and the area just proximal to this is swung medially so that it comes in contact with the rectum at a point below the site of proposed division of the rectum. The sigmoid and rectum are now tacked together for 1 to 2 inches by interrupted stitches along the longitudinal muscle bundle. *The next step is important because it makes the point of division of the bowel extra-peritoneal.* The anterior parietal peritoneum of the abdominal incision is separated from the muscles by blunt dissection so that on both sides of the abdominal incision the peritoneum falls without tension to the posterior parietal peritoneum on both sides of the bowel (Fig 4, c). At this area the cul-de sac is practically obliterated by suture of the anterior parietal peritoneum to the posterior parietal peritoneum and the proposed site of resection of the two loops of bowel is therefore extra-peritoneal (Fig 5). At this point the remainder of the operation is carried out by obstructive resection as described by Rankin. Payr clamps are placed on the bowel below the growth and on the sigmoid above it both clamps being just proximal to the suture of the rectum and sigmoid previously carried out.

The abdominal wall is closed in layers below the clamps around the bowel and the tumor containing the bowel is removed by cautery above the Payr clamps. Strips of iodoform gauze are carefully tucked in between the bowel and the abdominal wall to create enough tissue reaction to prevent spreading infection when the clamps are removed. Varying Rankin's technique, we remove the clamps the next day and immediately apply a spur crushing clamp to enlarge materially the opening between the afferent and efferent loops of bowel. It is this particular step of the operation that in our opinion makes this operation much more useful in its final result than an end-to-end anastomosis of the bowel which at this area is difficult to do and which is very apt to break down. This means infection, scar tissue, retraction of the rectal and sigmoid loops and resulting narrow lumen at the attempted site of anastomosis. After application of the spur crushing clamp

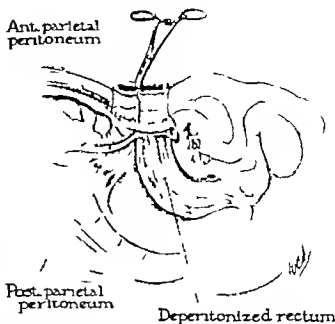


Fig 5. Lateral view showing afferent and efferent loops of bowel brought together after removal of the tumor. Peritoneum of cul-de-sac elevated to meet mobilized anterior parietal peritoneum, making point of resection of the bowel extra-peritoneal. Spur crushing clamp in place. At a later date bowel continuity is re-established.

nothing is done to re-establish continuity for 3 months. If bowel continuity has not been accomplished in that time a second operation under local anesthesia is done, the ends of the bowel mobilized where they are not in union, and a three layer suture carried out.

We have performed this operation only eight times in 10 years but in those cases in which it has been done we have had no operative deaths and no local recurrence and one 75 year old patient is alive and well 9½ years from the time of her operation. 1 patient is well 5 years. 1 patient 3½ years. Three are dead of general metastases in liver and lungs, and the 2 others are alive and without recurrence but the operations were done in the past 2 years.

It is, of course open to question whether any operation for cancer should optionally be done that in any way varies from the utmost radicality. Personally I believe that there are instances in carcinoma of the recto-sigmoid in which this type of less radical procedure is indicated always keeping in mind that the end results of any operation for cancer speak with the greatest authority

I SIMULTANEOUS VEIN LIGATION

AN EXPERIMENTAL STUDY OF THE EFFECT OF LIGATION OF THE CONCOMITANT VEIN ON THE INCIDENCE OF GANGRENE FOLLOWING ARTERIAL OBSTRUCTION¹

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ALTHOUGH the opinion generally prevails that purposeful occlusion of a healthy vein by ligation is a useful method for the prevention of gangrene due to the obstruction of large arteries, some investigators have expressed a doubt as to the value of this procedure. Also surgeons are prone to employ the method as a routine procedure rather than to use it for a particular set of conditions not frequently encountered. The fundamental problem, therefore, in determining the therapeutic value of the simultaneous ligation of a vein is first to determine whether this procedure will under any conditions influence favorably the incidence of gangrene after arterial occlusion and second, to determine if possible the exact conditions which constitute the indication for its employment.

The conditions attending the employment of simultaneous ligation of veins in clinical surgery are so complex and are so infrequently observed by one individual that the effects due solely to this procedure are difficult to determine. Fortunately, however, the problems associated with this procedure would seem to be particularly suitable for solution by animal experimentation. Experimental evidence thus far submitted is conflicting. It is the purpose of this paper to deal only with the results obtained from experimental studies.

The first significant experimental study of the effect of simultaneous ligation of veins on the incidence of gangrene following arterial occlusion was that of Brooks and Martin (1). In this experimental study 3 phases of the problem were particularly investigated.

1. Using the temperature of the tissues as a criterion of volume flow of blood through the tissues, we found that ligation of the concomitant vein produces a further decrease in blood flow than that which had followed obstruction of the artery.

2. Ligation of the concomitant vein caused an increase in the intravascular pressure in all the vessels in which the pressure had been previously diminished by ligation of the artery.

3. Ligation of the right common and right external iliac artery in 21 rabbits was followed by gangrene of the extremity in 15 instances (71.5 per cent). The same ligation of arteries with ligation of the right common iliac vein in 18 rabbits was followed by gangrene of the extremity in 6 instances (33.3 per cent).

Since the publication of this experimental study by Brooks and Martin the effects of simultaneous ligation of the veins upon the blood pressure and blood flow in the vessels distal to the point of ligation have been confirmed by Pearse, Montgomery and Wilson, Holman and Edwards confirmed the results obtained by Brooks and Martin as concerning the effect of simultaneous ligation of the vein on blood pressure, but believed the volume flow of blood was increased. The method employed by Holman has been criticized by Brooks (2). Mulvihill, Harvey and Doroszka and Wilson and these investigators have shown that the results obtained by Holman and Edwards were evidence for diminution rather than augmentation of the volume flow of blood.

The experiments described by Brooks and Martin in which the effect of simultaneous ligation of the concomitant vein on the incidence of gangrene was determined have recently been repeated by Wilson whose results are contrary to those obtained by Brooks and Martin. Wilson performed a larger number of experiments than Brooks and Martin and found that the incidence of gangrene was not changed by simultaneous ligation of the concomitant vein. This publication of Wilson's has brought about an extraordinary clarification of the entire question of the effectiveness

TABLE I

	A Arteries loose ligated Number	B Arteries and vein ligated Number
Total number of experiments	100	100
	Per cent	Per cent
Slight muscle or temperature changes	33	56
Complete paralysis	66	44
Focal gangrene	17	2
Massive gangrene	29	2
Late ulceration	7	6
Contracture	15	4

of the procedure designated as "simultaneous ligation of the vein" because it, so to speak, puts the question back to the beginning by changing the problem from one of how an effect is produced to whether the effect is produced.

It is worth while calling attention to an inconsistency which exists in Wilson's publication between the statement that simultaneous ligation of veins influences the amount of diminution in volume flow and may influence intravascular pressure after arterial obstruction, and the assertion that this same simultaneous ligation of veins does not influence the incidence of gangrene, nor the severity nor the distribution of muscle necrosis after arterial occlusion. I believe it would be universally admitted that diminution in the volume flow of blood and a decrease in the intravascular pressure are the primordial effects of arterial obstruction and that these effects are, so to speak, the sole and proximate cause of the necrosis which follows. From this it would seem as if the conclusion were inevitable that any effective influence which were brought to bear upon the quantity of change in either the volume flow of blood or the intravascular pressure must influence in one way or another the incidence of gangrene, unless it were assumed that there was always an exact balance of the favorable influence of the change in one and the unfavorable influence of an obligate change in the other.

The purpose of this paper is to report the results obtained from a more frequent repetition of the experiments originally described by Brooks and Martin.

Rabbits were used as the experimental animals. An attempt was made to repeat in

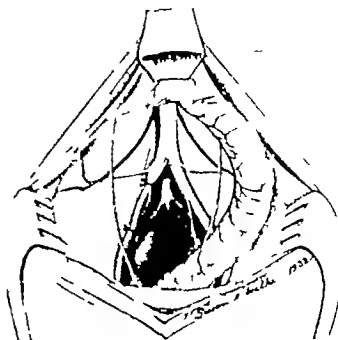


Fig. 1. Drawing illustrating sites of application of ligatures to artery and vein.

each experiment as nearly as possible the same operative procedure. The abdomen was opened in the midline. The terminal aorta was located. The division of the common iliac artery was identified. The external iliac artery was exposed and ligated just distal to the origin of the hypogastric artery. Exposure of this vessel also exposed the common iliac vein. In the experiments in which the vein was ligated the ligature was applied to the vein at this time. Ligature was then applied to the common iliac artery just proximal to the origin of the hypogastric artery. Thus in each experiment with or without ligation of the vein the same operative exposure was used. Fine silk thread was used in all experiments for the ligatures. Sufficient care was used to feel confident that the artery or vein was always occluded. (Note this method of ligation is the same as in the experiments of Brooks and Martin but different from that of Wilson who employed 2 ligatures with division of the artery between.) The sites of the ligatures are shown in Figure 1.

After operation the animals were carefully observed each day until death or the development of obvious gangrene or until a period of 10 days had elapsed. All the animals which lived longer than 10 days were observed

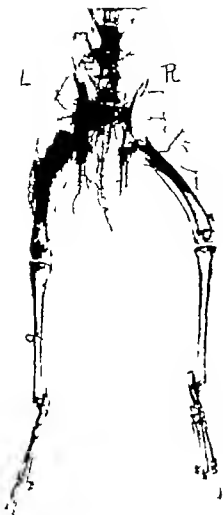


Fig. 2. Roentgenogram of arteries injected with barium sulphat. 5 days after ligation of right common and external iliac arteries and common iliac vein. The animal showed complete paralysis of the right extremity. Note obliteration of the artery at the site of ligation and injection of the arterial tree distal to point of ligation through collateral circulatory bed. (Compare with Fig. 5.)

twice each week in order to determine the nature and extent of the "late" effects of arterial obstruction such as ulceration or contractures. All animals were carefully examined at autopsy.

In 107 experiments the arteries alone were ligated. Both the artery and vein were ligated in 113 experiments. The results obtained showed a striking difference in the incidence

of gangrene which followed ligation of the artery alone and that occurring after the ligation of both artery and vein. In each series of experiments there were at least a considerable number of animals which died too soon after operation for the development of the unmistakable evidence of gangrene. But each series contains 100 instances of observations on animals which lived long enough for there to be no doubt about the presence or absence of gangrene. A summary of the results obtained in only those experiments in which it seemed there was no doubt about the presence or absence of gangrene is shown in Table I. This table shows that ligation of the common and external iliac arteries in 100 rabbits was followed by necrosis of a sufficient amount of tissue to be apparent on gross examination in 46 instances and that ligation of the common and external iliac arteries with simultaneous ligation of the common iliac vein in 100 rabbits was followed by evidence of necrosis on gross examination in 4 instances. It is also worth while to call attention to the relationship existing between the incidence of the various degrees of gangrene observed in the two series of experiments. Massive gangrene of almost the entire extremity was 14.5 times more frequent after ligation of the artery alone while gangrene limited to portions of the extremity was only 8.5 times more frequent. Necrosis of the skin leading to late ulceration occurred in about the same frequency with or without ligation of the vein which is in agreement with the idea previously expressed by Brooks that changes observed relatively late after sudden arterial occlusion were not a part of the problem concerning the effects of simultaneous ligation of the vein in the incidence of gangrene.

As has already been stated an attempt was made to have the same conditions concerning arterial obstruction present in each series of experiments. A study however of the configuration of the arterial tree as indicated by injection of an opaque substance showed the impossibility of attaining this desired end. In 30 of the experimental animals the arterial tree was filled with an injection mass opaque to the roentgen ray. From an examination of the configuration of the arterial tree it was

obvious that there was often a difference in size and origin of branches of the common iliac arteries but this demonstration is after all no more than an illustration of a fact already known because the very fact that all animals with arteries alone ligated did not develop the same results could hardly be explained in any other manner than by the assumption that there were variations in the amount of obstruction to the blood flow.

A comparison of the roentgenograms of the injected extremities with the physiological changes observed also served to emphasize the fact that the adequacy of the circulation of an extremity cannot always be estimated by the results obtained from the injection of its arteries. Figures 3 and 4 show the roentgenograms of 2 rabbits killed 5 days after the common and external iliac arteries and the common iliac vein had been ligated. There was almost complete paralysis of the entire extremity of the rabbit in which it was possible to inject the artery distal to the obstruction through the collateral circulation and very little evidence of diminished blood flow in the animal in which none of the injected mass passed through the collateral circulation. Both injections and direct examination of the arteries showed complete occlusion at the site of ligature. Neither animal showed any evidence of necrosis.

The occurrence of contractures after ligation of arteries and of arteries and veins was observed in these experiments. This particular effect of arterial occlusion has been previously investigated by Brooks who studied the effects of temporary and permanent obstruction of arteries and veins on necrosis and fibrosis of muscle. Brooks differentiated the pathogenesis of contractures following arterial obstruction from those following venous obstruction. He showed that the former develop later and are not attended by such a degree of severity of inflammation as is associated with the contractures attributable to venous obstruction. In the experiments which constitute the basis of the present paper contractures developed in 15 animals in which the arteries alone were ligated and in only 4 instances in which both arteries and veins were ligated. This difference in inci-



Fig. 3 Roentgenogram of arteries injected with barium sulphate 5 days after ligation of right common and external iliac arteries and common iliac vein. The animal showed only slight evidence of muscle weakness. Note obliteration of the artery at the site of ligature but little injection of the arterial tree distal to the ligature through collateral circulatory bed. (Compare with Fig. 2.)

dence of contractures becomes more striking if only the animals which lived for 5 or more days are considered. In the series of experiments in which the arteries alone were ligated only 58 animals lived 5 or more days while 70 animals with both arteries and veins ligated lived for more than 5 days.

Contractures due to growth of connective tissue and scar formation have an entirely

different relationship to a serious impairment of the circulation than gangrene or ulceration. Gangrene, necrosis and ulceration are the immediate and direct effects of deficient blood flow. Proliferation of connective tissue, scar formation and contracture belong to the process of repair. Contractures after arterial obstruction are therefore evidence of a previous impairment of circulation sufficiently great to produce necrosis in tissues more vulnerable than connective tissue. The fact that contractures are less frequently observed after arterial obstruction and simultaneous venous obstruction than after arterial obstruction alone indicates that simultaneous occlusion of the vein aids in the preservation of the vitality of the more vulnerable tissues during the critical period before the re-establishment of circulation through the collateral vessels.

The results obtained in these experiments

indicate that simultaneous ligation of the concomitant vein influences favorably the incidence of gangrene after ligation of the common and external iliac arteries in rabbits. Because of the impossibility of obtaining the same degree of arterial obstruction in successive experiments, this conclusion rests solely upon statistical evidence. A final conclusion can be reached only after the accumulation of a large number of experiments performed by independent investigators.

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STUDIES ON ENDOBRONCHIAL OCCLUSION

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THE chief reason for experimental attempts to create bronchial occlusion is largely the hope that it will be of benefit in the treatment of pulmonary tuberculosis. Many academic and subsidiary stimuli play a part in the attempts to produce this and those who have attempted to reproduce certain postoperative pulmonary complications, notably massive collapse, have struggled with the matter. The major reasons for this undertaking may be listed as follows:

1. There are to be found in the literature many reports of patients suffering from pulmonary tuberculosis in which atelectasis of the diseased lobe occurred. This atelectasis was due in some cases to the disease itself occluding the bronchus or the atelectasis was brought about through another mechanism. Recently Jacobaeus, Packard, Gatterdam, Korol, and others have pointed out that the so called fibrotic lung seen in pulmonary tuberculosis is really an atelectatic lung due to bronchial obstruction, and that the disease in this fibrotic lung is usually a benign process. Other cases in which atelectasis has occurred in association with pulmonary tuberculosis with benefit to the patient are found in the reports by Eloesser, Stoloff, and Farris.

2. For the last 10 years interest in the physiology and surgery of the lung has been unusually active, partly because the physiologist has turned to the lung in the study of the circulation and partly because experiments have been designed to reproduce certain postoperative pulmonary complications chiefly massive collapse (atelectasis) and abscess. This interest has led to much ingenious investigation, resulting in important additions to our knowledge of pulmonary physiology and pathology. Chief among these accessions is our present conception of atelectasis as a disorder due to bronchial occlusion.

3. We have also the academic logic that, in tuberculosis, rest and approximation of the walls of cavities are the maximum desiderata

in therapy (8). It would appear that atelectasis of the diseased lobe might accomplish this far more easily than would the major surgical procedure of extrapleural thoracoplastic collapse operations. Also the bacteriological studies of Novy and Soule have demonstrated that the tubercle bacillus is a strict aerobe and does not survive well under anaerobic conditions. This suggests that any means which prevents air from approaching the active tuberculous focus is desirable.

4. Finally there is in favor of a selective collapse of the lung the fundamental consideration that fibrosis is stimulated by anaerobic conditions. Coryllos (9) has pointed out that this condition in the lung would be favored by atelectasis. The extreme fibrosis noted by Schlaepfer following ligation of the major branches of the pulmonary artery is in line with this thought.

The attempts to create stenosis experimentally by the endobronchial route began with the investigations of W. E. Adams and Chester M. Van Allen, in 1930, by the study of bronchial injury and repair. They reported the effect of applying to the bronchial mucosa a silver nitrate stick and hot cautery. In their study of the repair processes following this, they noted that several animals survived with complete occlusion. In 1931 Adams and Livingstone (2, 3) published further experimental work on obstructive pulmonary atelectasis and persistent bronchial fistulae in which the bronchi were completely occluded by applying 50 per cent and 35 per cent silver nitrate solution to the bronchial mucosa. They were able to produce bronchial occlusion by a single application of the above solutions. This bronchial occlusion resulted in pulmonary atelectasis in all cases in which the occlusion was complete and in which all the bronchi to the lobe were occluded. The bronchial fistulae closed. These studies were elaborated upon and supported by further reports published in 1932 (4). In this latter



Fig. Animal N. 5733. X-ray of the chest following three bronchial treatments with acid acriflavine solution. At autopsy the entire left lung was atelectatic. This film shows the heart displaced against the left chest wall, the left diaphragm high and the left apex cloudy.

article stronger concentrations were used and a 75 per cent silver nitrate solution was shown to cause sloughing of the bronchial wall. Where atelectasis occurred, it was found that the fibroblastic proliferation was very pronounced. Finally in 1932 these same investigators applied their ability to produce occlusion by this method to the operation of lobectomy (5). By producing a preliminary bronchial occlusion through the application of silver nitrate solutions they reported greater ease and safety with the procedure.

Other investigators have repeated the work cited without being able to support entirely their contentions for the mortality rate in other hands has been high, and occlusion has resulted only infrequently. Blalock, using 35 per cent silver nitrate solution lost 15 out of his first 20 animals and complete stenosis was an infrequent result. Recently Dr Van Allen told us personally that he himself was unable to duplicate the results published by his associate Dr Adams. In the surgical labora-

tones in Cleveland Dr Robert Zollinger repeated the work in the winter of 1931-1932 without more success than Blalock. Positive occlusion was so rare or the mortality so high that little hope for clinical application could be seen. Other caustics were utilized without greater success.

Beginning in the fall of 1932 we recommenced a study of this problem because of the great clinical value such a method would have were it safe and certain. We began by repeating the experiments of Adams and Livingstone following their technique as closely as their publications permitted. A pledget of cotton moistened with 35 per cent of silver nitrate solution held in the tip of a bronchial applicator was pressed against the mucous membrane of a bronchus at selected points. Both dogs and monkeys were used. They were anesthetized before each procedure by the intraperitoneal injection of sodium pentobarbital.

In a series of 20 dogs one application of the 35 per cent silver nitrate solution failed to produce complete occlusion. Repeated applications yielded only three instances of occlusion with atelectasis. In the same series a marked pneumonitis or hemorrhagic infarct formation occurred in the lung distal to the application and destruction of the bronchus so great as to result in fatal hemorrhage occurred six times. In one experiment a large giant *Macacus Rhesus* monkey was bronchoscope repeatedly over a course of 4 months, and a 35 per cent solution of silver nitrate was applied to the bronchus of the right accessory lobe five times during this period. At the end of 5 months this bronchus was constricted to about one half or one third of its original diameter but there was no atelectasis distal to the constriction.

In a second series of animals a modified Carnoy's¹ solution was used carrying out experiments similar to those of Dr Zollinger in 1931. This caustic fluid developed by Zollinger and Moritz in an attempt to secure the optimum fixation in intracranial cysts

This solution is made as follows:

Absolute alcohol	6 cubic centimeters
Chloroform	3 cubic centimeters
Glaucol ether and	3 cubic centimeters
Picric chloride	gram

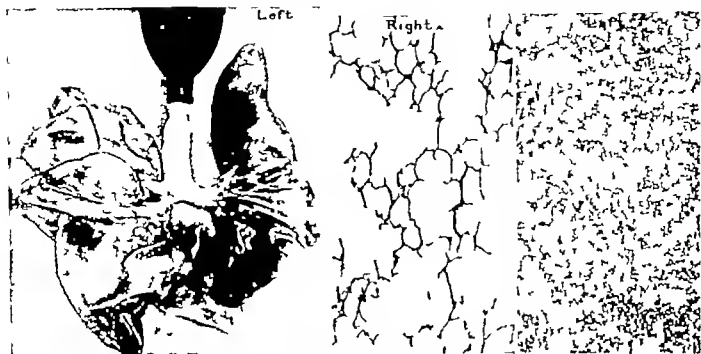


Fig 2. Animal No 15733. Photograph of gross specimen and photomicrographs of sections removed from right and left lungs. The atelectatic left lung appears larger than its true size, for it was stretched upon the background

when photographed. When the trachea and right lung were distended with air, the left lung was atelectatic and airless. The roentgenogram of the chest in this case is shown in Figure 1.

without deep penetration has also been used to produce obliteration of cervical fistulae and pilonidal sinuses (10). It has properties of moderate penetration with rapid local fixation of cells. Rather marked local fibroblastic reaction occurs in the tissues after its application. This solution was used intrabronchially in 5 animals, the same technique being utilized. It produced a rapid necrosis of the epithelium and bronchial cartilages, with a subsequent fibrosis which in 2 cases resulted in bronchial occlusion and atelectasis. But occlusion occurred without regularity and there occurred three instances of pulmonary hemorrhage and pulmonary gangrene and abscess formation. This experience, which was similar to that of previous investigations by Zollinger with the same fluid, convinced us that this solution was too caustic in its action and without a sufficient margin of safety to warrant further work with it.

The next attempt was a return to the earliest experiments of Van Allen and Adams (1). These investigators reported that the cicatrix resulting from the application of actual cautery to the bronchial membrane caused occlusion. In these experiments the surround-

ing blood vessel wall and lung showed much less reaction following cauterization with heat than following cauterization with silver nitrate. An insulated metal rod the end of which was capped by a small uninsulated metal ball was attached to the fulgurating current of the Bovie unit and passed down the bronchus to the desired location. The ball tip was made to lie against the whole bronchial wall and weak desiccating current turned on for 5 seconds. Experience with varying amplitudes of current resulted in our standardizing the dose to the desiccating current at stop 25. Eighteen animals were used. Two of the animals in this series developed bronchial occlusion upon a single cauterization, 2 others developed occlusion after two to four cauterizations. Postoperative hemorrhage and gangrene of the lung resulted in ten instances. This experiment suggested that its practicability was extremely limited.

Comments. The experience with these three methods—silver nitrate, Carnoy's fluid and electrical cauterization—showed them to be fraught with considerable danger as well as unreliable in the production of occlusion. Such methods seemed too crude, and either pro-



Fig. 33. Animal N. 5. X-ray of the chest following three bronchial treatments with acid acriflavine solution. At autopsy the entire left lung was atelectatic. This film shows the heart displaced against the left chest wall, the left diaphragm high, and the left pericardium

article stronger concentrations were used and a 75 per cent silver nitrate solution was shown to cause sloughing of the bronchial wall. Where atelectasis occurred, it was found that the fibroblastic proliferation was very pronounced. Finally in 1932 these same investigators applied their ability to produce occlusion by this method to the operation of lobectomy (5). By producing a preliminary bronchial occlusion through the application of silver nitrate solutions they reported greater ease and safety with the procedure.

Other investigators have repeated the work cited without being able to support entirely their contentions for the mortality rate in other hands has been high, and occlusion has resulted only infrequently. Blalock, using 35 per cent silver nitrate solution lost 15 out of his first 20 animals and complete stenosis was an infrequent result. Recently Dr. Van Allen told us personally that he himself was unable to duplicate the results published by his associate Dr. Adams. In the surgical labora-

tories in Cleveland Dr. Robert Zollinger repeated the work in the winter of 1931-1932 without more success than Blalock. Positive occlusion was so rare or the mortality so high that little hope for clinical application could be seen. Other caustics were utilized without greater success.

Beginning in the fall of 1932 we commenced a study of this problem because of the great clinical value such a method would have were it safe and certain. We began by repeating the experiments of Adams and Livingstone following their technique as closely as their publications permitted. A pledget of cotton moistened with 35 per cent of silver nitrate solution held in the tip of a bronchial applicator was pressed against the mucous membrane of a bronchus at selected points. Both dogs and monkeys were used. They were anesthetized before each procedure by the intraperitoneal injection of sodium pentobarbital.

In a series of 20 dogs one application of the 35 per cent silver nitrate solution failed to produce complete occlusion. Repeated applications yielded only three instances of occlusion with atelectasis. In the same series a marked pneumonitis or hemorrhagic infarct formation occurred in the lung distal to the application and destruction of the bronchus so great as to result in fatal hemorrhage occurred six times. In one experiment a large giant *Macacus Rhesus* monkey was bronchoscope repeatedly over a course of 4 months, and a 35 per cent solution of silver nitrate was applied to the bronchus of the right accessory lobe five times during this period. At the end of 5 months this bronchus was constricted to about one half or one-third of its original diameter but there was no atelectasis distal to the constriction.

In a second series of animals a modified Carnoy's solution was used carrying out experiments similar to those of Dr. Zollinger in 1931. This caustic fluid developed by Zollinger and Moritz in an attempt to secure the optimum fixation in intracranial cysts

This solution is made as follows:

Alcohol 100 cc.
Chloroform 100 cc.
Glacial acetic acid 100 cc.
Ferric chloride 100 cc.

4 cubic centimeters
3 cubic centimeters
cubic centimeter
gram



Fig 4. Animal No 29-33. Hemastorylin and eosin stain. Gross specimen showing the complete atelectasis of the right middle, lower and accessory lobes. The X ray of this animal is shown in Figure 3. The photomicrograph

labeled left was taken from the normal left lung. The photomicrograph labeled right was taken from the atelectatic right lung distal to the bronchial occlusion. The magnification is the same in both sections. $\times 80$

which are ramifications of the lower primary bronchus were treated in the manner described. If the entire right or left main primary bronchus was to be treated a cotton wick $\frac{1}{8}$ centimeter by 5 to 8 centimeters, from which all excess of acriflavine had been pressed out with a sponge, was passed through the bronchoscope and packed tightly into the main primary bronchus and left in place for 15 or 20 minutes. Upon removal of the wick the area was carefully wiped to remove any excess solution. Following this method the primary bronchus can be completely occluded; two applications usually being necessary.

The solution of acriflavine should be made up fresh each day that it is used as exposure decreases its efficiency. If two or more bronchi are to be treated it is wise to use a fresh cotton applicator for each bronchus as the secretions moisten the applicator and dilute the concentration of the acriflavine.

A large series of animals were treated with acriflavine. We began by using a 10 per cent solution (7 animals) but soon found the caustic effect was inadequate at this concentration. A summary of the protocols show that one bronchial occlusion (accessory lobe) resulted from a single application and that one oc-

clusion resulted from repeated applications (three applications to accessory or subcardiac lobe). The remaining animals were treated with 25 per cent acriflavine. In this group occlusion resulted with great regularity when the technique had become standardized. The fatalities are discussed in detail and are sufficiently explainable on technical grounds or other accidents to justify our hopes that a satisfactory and safe method for creating bronchial occlusion has been found.

SUMMARY OF EXPERIMENTS WITH 25 PER CENT ACRIFLAVINE

- 44 animals
- 13 sacrificed before the twenty first day for histological study of the healing process.
- 31 animals available for study of occlusion and its risk
- 11 died
 - 2 of distemper
 - 3 of gross injury from instrumentation on operating table
 - 1 of fight in kennels.
- 2 of special experiment in which one half cubic centimeter of fluid was left in bronchus for study of histological reaction in lung
- 1 of hemorrhage from sloughing of bronchial wall—this animal was treated twice in the same afternoon for a total of 21 minutes with a free interval



Fig 5 Animal No. 32-33 X-ray showing normal chest. The diaphragm is similar in position, the lung fields are of equal intensity, the heart apex is just to the left of the midline.



Fig 6 Animal No. 32-33 X-ray of the chest of the same animal taken 53 days later. Autopsy showed the entire left lung to be atelectatic and azygous. The left primary bronchus was treated twice with 25 per cent acid acriflavine solution. The atretic lung which appears just under the heart is the displaced right accessory lobe.

- 2 of pneumonia which began in the lobe treated by this fluid
- 20 survivals for testing efficiency of acriflavine solution in producing occlusion
- In 24 instances occlusion resulted from a single application
- In 19 instances occlusion resulted with from 2 to 3 applications

The chart which summarizes the experiments with acriflavine shows at least two fatalities in the group of animals which succumbed (those in which pneumonia developed) for which the application of the drug seems directly responsible. Because of the large experience in which a similar unfortunate result did not occur we feel that in these animals either the fluid applied was excessive and escaped down into the lobe or we may have been dealing with animals on the verge of distemper. No abscess formation occurred and microscopically we did not observe damage to blood vessels.

All of the different bronchi have been completely stenosed. In several cases the entire lung has been made to collapse completely

due to occlusion of all its bronchi. The smaller bronchi are more easily occluded. We found greatest difficulty in collapsing the right lower lobe, probably because its many small bronchi led us to miss one of these during an application thereby necessitating a second or third application.

The success in the last 20 cases, the histological study of the healing process, and the simplicity of the procedure have encouraged us to the point where we feel justified in progressing to the application of this work to our clinical cases.

PROTOCOLS OF TYPICAL EXPERIMENTS

F 137-33 A brown mongrel, male dog. Temperature 102 degrees.

March 19, 1933. The dog appeared to be in good condition. A preliminary X-ray of the chest was taken. The dog was anesthetized with sodium pentobarbital intraperitoneally. The bronchoscope was inserted, and the left primary bronchus was identified. Into each of the divisions of the primary bronchus was inserted for 5 minutes a cotton sponge

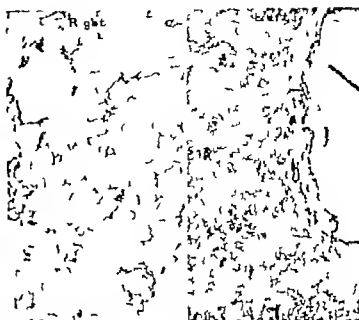


Fig. 7. Animal No. 13233. The lungs and trachea of a case which had been treated twice with a solution of acid acriflavine. The left lung is collapsed and alveoli and the left bronchus occluded. The photomicrographs of sections from the right and left lungs are the same magnifications.

The photomicrograph of the left shows the alveoli collapsed and alveoli and the moderately sized tertiary bronchus filled with mucoid material. The vascular supply is intact.

moistened with a 25 per cent acid acriflavine solution. Following this, each of the orifices were red dened and puckered in appearance.

March 21. The dog was up and about in his cage coughing considerably but otherwise in good condition. Temperature 102.2 degrees.

March 23. The dog was returned to his cage on the roof. His appearance and actions seemed to be normal.

March 31. The general condition of the animal was good. X ray of the chest was taken. The dog was anesthetized and bronchoscoped. The left primary bronchus was identified and the bronchoscope was inserted into it. The bronchus leading to the upper lobe was still patent though greatly reduced in size. A 25 per cent solution of acid acriflavine was applied here for 3 minutes. The distal primary bronchus was practically occluded by a marked stenosis, and no other secondary bronchi could be identified. This portion was similarly treated.

April 24. The dog was in excellent condition. X ray showed the heart almost against the left chest wall and the left lung almost completely atelectatic. The animal was anesthetized and bronchoscoped. All of the secondary bronchi were completely stenosed except one very small bronchus that lay on the floor of the primary bronchus and had not been treated previously. The distal primary bronchus was completely occluded by a firm cicatrix. The small orifice which had not been treated was now treated with 25 per cent acid acriflavine for 5 minutes.

April 25. The dog was up and about and in good condition. A slight hacking cough was present yet.

May 15. X ray showed all of the lobes of the left lung to be completely atelectatic, and the heart against the left chest wall. The left diaphragm was high. The dog was bronchoscoped. The left primary bronchus was found funnel shaped and it tapered to a complete occlusion. All of the secondary bronchi were completely occluded.

Intrapleural pressures were taken on both sides which showed no essential variation from normal. On deep inspiration the negative pressure on the atelectatic side fell to minus 12 centimeters of water and on the normal side to only minus 8 centimeters of water.

Blood gas analysis by the Van Slyke method showed no significant changes.

June 26. Temperature 102.2 degrees. The dog was in excellent condition ate well and appeared active and normal. X ray of the chest (Fig. 1) showed complete atelectasis of the left lung heart against left chest wall, and left diaphragm high.

June 29. The dog was killed with ether intra venously. The heart and lungs were removed (Fig. 2). The lobes of the left lung were small and shriveled and of a brownish blue color. The lobes were non crepitant and uniformly firm. The pleura which covered them was entirely smooth and shiny and with out adhesions. Cut sections showed a uniformly hepatized appearance. The tissues were firm non friable and the smaller bronchi, within the lung substance were filled with a mucoid material.

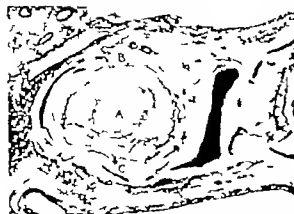


Fig 8. Bronchus 6 day after treatment. The lumen is filled with a firmly adherent mucoid plug. Many of the cartilages, B, are necrotic. Submucosa, C, homogeneous and undergoing septic necrosis. Hematoxylin and eosin stain $\times 9$.

Feb 20-23. Brown, mongrel dog. Temperature 101.4 degrees.

March 8 1933. X-ray of the chest showed it to be normal. The dog was fastened to the table, anesthetized, and the bronchoscope inserted. The right primary bronchus was identified. Each of the branches, except the right upper was found and treated with a 25 per cent acid acriflavine sponge, which was carefully fitted into the orifice snugly and left in place for 5 minutes. Following this procedure



Fig 10. Bronchus 12 days after treatment. The mucoid case has been separated from the bronchial wall and expelled. There is a marked proliferation of the peribronchial tissues and submucosa. Hematoxylin and eosin stain $\times 25$.



Fig 9. High power magnification of the same bronchus. Hematoxylin and eosin stain $\times 40$.

the primary bronchus was carefully sponged to remove any excess fluid. The treated areas were moderately stained and withered and wrinkled in appearance.

March 10. The dog appeared normal. However a moderate hacking cough was present. The dog ate well and played actively with the other dogs.

March 23. X-ray of the chest showed no essential variation from normal. The dog was anesthetized with sodium pentobarbital intraperitoneally and bronchoscoped. The right primary bronchus was rather markedly constricted so that the bronchoscope was passed into it with difficulty. The orifices of the secondary bronchi leading to the individual lobes, excepting the right upper, were shrunken, edematous, but not occluded. There was no erosion



Fig 11. The occluded bronchus 25 days after treatment. The cartilages are misshapen and displaced. The lumen is filled with granulation and scar tissue. There are present many small epithelial inclusion cysts. The lung distal to this bronchus was entirely atelectatic. Hematoxylin and eosin stain $\times 10$.

of the mucous membrane. Each of the lobe bronchi was treated for 5 minutes with 25 per cent acid acriflavine solution.

April 11 The animal was in good condition. Temperature 102 degrees. X ray (Fig. 3) showed the right middle, lower and accessory lobes completely atelectatic, the heart drawn over against the right chest wall, and the right diaphragm high.

May 2 Blood gas analysis by the Van Slyke method showed little significant change from normal. The dog was anesthetized and bronchoscoped. The right primary bronchus was completely occluded just beyond the carina. The mucous membrane covering the occlusion appeared normal. The right upper lobe bronchus was partially occluded.

June 29 The dog was in excellent condition. X ray of the chest showed the right middle lower and accessory lobes completely atelectatic, the heart drawn over against the chest wall, and the right diaphragm high. The dog was killed with ether intravenously. The right accessory, lower and middle lobes were small, shrunken and of a dark brownish purple color (Fig. 4). These lobes were completely atelectatic and contained no air. The pleura everywhere, was smooth and shiny and there were no adhesions. The bronchi leading to the lobes were small, sclerosed, and felt pipestem like. The bronchial lumen was completely filled with clot. The atelectatic lung was of uniformly smooth consistency, and the small bronchi within the lobes were filled with a mucoid material.

F 132 33 Female collie dog Temperature 101.6 degrees

March 11 1933 X ray of the chest was taken which showed it to be normal (Fig. 5). The dog was fastened upon the operating table and anesthetized with sodium pentobarbital intraperitoneally. The bronchoscope was inserted into the trachea, the carina identified and the left primary bronchus entered. All of the orifices of the secondary bronchi which lead from the primary were treated for 5 minutes with a 25 per cent aqueous solution of acid acriflavine the routine technique being used. Following this the main primary bronchus was packed, for 5 minutes with a wick which had been soaked in the acriflavine solution and all of the excess solution expressed. Following this procedure the mucous membrane was stained a deep scarlet color.

March 12 The dog was up and running about. He had a moderate cough but otherwise his appearance and actions were normal.

March 13 The dog was in good condition. Temperature 102.4 degrees

March 31 An X ray of the chest showed no atelectasis, and the heart was in the normal position. Sodium pentobarbital was given intraperitoneally and the animal was bronchoscoped. The left primary bronchus was markedly constricted so that the bronchi to the individual lobes could not be visualized. The mucosa was intact, and there was no bleeding. The point of stricture in the primary bronchus was treated for 5 minutes with a cotton

applicator moistened with a 25 per cent solution of acid acriflavine.

April 2 The dog was in good condition ate well and appeared entirely normal.

May 4 An X ray of the chest showed the heart within the left chest against the lateral chest wall. The left lung was entirely atelectatic and collapsed.

June 20. The dog was in good condition. Temperature 102 degrees. An X ray (Fig. 6) showed complete atelectasis of the entire left lung and a high left diaphragm. Intrapleural pressures were taken which on the left side, varied from minus 14 centimeters of water to minus 20 centimeters of water. In the right chest the intrapleural pressure varied from minus 8 centimeters of water to minus 13 centimeters of water.

Blood gas analyses by the Van Slyke method showed no appreciable changes.

The dog was anesthetized with sodium pentobarbital intraperitoneally and bronchoscoped. The left primary bronchus was entirely constricted and occluded 7 centimeters below the carina. The dog was killed with ether intravenously and the heart and lungs removed. The trachea was attached to a rubber bulb and the lungs distended with air (Fig. 7). The right lung ballooned with air and was entirely normal in appearance. The lobes of the left lung were airless small and shrunken, and probably less than one third of their normal size. The pulmonary tissue was of the same color and consistency as normal liver but much less friable. Complete atelectasis of the entire left lung was present.

PATHOLOGY

Acriflavine solutions of various strengths were tested upon the bronchi those solutions of less than 25 per cent proved ineffective. The dye is soluble in water only to 33 per cent under normal conditions and it was felt that the danger of introducing particles of undissolved dye into the bronchus prohibited the use of any stronger solution. A group of animals treated with 25 per cent solutions of acriflavine were sacrificed at intervals and gross and microscopic studies made.

Two hours At autopsy the lobe appeared normal in size and color and consistency. The bronchus which led to this was stained a diffuse yellow and the dye could be seen penetrating to the peribronchial tissues.

One day The lobe appeared normal. It was crepitant and of normal color and consistency. The bronchus leading to it was slightly stained yellow the surface appeared swollen and lacked its normal glistening appearance.

Microscopically the bronchial mucosa and musculature were necrotic and the peribronchial tissues in the immediate vicinity of the cartilages showed a rather homogeneous appearance with a poor nuclear stain. The larger blood vessels showed no damage. The pulmonary tissue in the immediate proximity was rather congested showed some hemorrhage and a few of the alveoli contained a hyaline membrane. Leucocytic infiltration was correspondingly absent. The peripheral lung except that surrounding the larger bronchi was entirely normal. The pulmonary tissue encircling these bronchi was congested and in a few isolated places the alveoli were filled with serum without cells.

Four to six days (Figs 8 and 9) At autopsy the lobe was a deep purplish color and smaller in size than normal. To palpation it was non-crepitant and seemed rather wet and boggy. There was no evidence of infiltration. The bronchus leading to it was occluded by a mucoid cast which was firmly adherent to the wall. Upon removal of the mucoid plug the orifice of the bronchus was rough and lacked its normal glistening appearance. Microscopic sections showed the epithelium and submucosa entirely replaced by a mucoid plug which filled the bronchial orifice and was adherent to the submucosa and in places to the pericartilaginous tissues. Many of the cartilages were necrotic. There was considerable granulation tissue and fibroblastic proliferation in the peribronchial tissues. In places there were a few lymphocytes and rare scattered leucocytes. The pulmonary tissues in the immediate proximity showed some organization with scattered patchy atelectasis. There was slight round cell infiltration. The distal lung was oedematous and showed some patchy atelectasis, but there was found no evidence of inflammation.

Eight to ten days At autopsy in most instances the lung was somewhat darker in color and was crepitant and air containing. Occasionally one or two patches on the surface were a deeper purple in color, were retracted from the surrounding lung and did not contain air. The bronchus was open, the mucoid plug having been expelled. The surface of the bronchus was somewhat smooth

and shiny, occasionally studded with petechiae. The lumen was somewhat decreased in size.

Microscopic section showed the surface of the bronchus lined with a thin layer of regenerating epithelium. In one in which the mucoid plug had not yet been expelled the regenerating epithelium was growing between the mucoid plug and the submucosa, separating the two and loosening the plug. The submucosa and perichondrial tissues were still necrotic and homogeneous, and showed no nuclear stain. There was no cellular infiltration. A majority of the cartilages were extensively damaged. The pericartilaginous tissues showed beginning regeneration with fibroblastic proliferation. The lung surrounding the bronchi showed some patchy atelectasis with scattered blood pigment. Evidences of infection were entirely absent.

Two weeks (Fig. 10) The gross appearance of the pulmonary tissues closely resembled those examined in 10 days.

Microscopically the sections of the bronchus showed the epithelium to be fully regenerated and without cellular reaction. There were occasional piled up areas of epithelial cells forming polyps. In many places just under the epithelial layer were nests of epithelial cells forming little inclusion cysts. There was slight beginning regeneration in the submucosa. The cartilages were necrotic, misshapen and in many instances rather markedly displaced from their normal position. The peribronchial tissues showed marked fibroblastic proliferation and regeneration. The lung in a few scattered areas which tended to follow the bronchial ramification within its parenchyma, still showed evidences of hemorrhage and congestion. Small zones of patchy atelectasis were still present.

Four weeks (Fig. 11) At autopsy the lobe was small shrunken and of a bluish purple color. It was rather firm, non-crepitant, and except for the fact that it was not friable, closely resembled liver tissue. It proved to be 100 per cent atelectatic. The bronchi within it were filled with a thick, tenacious mucus. The primary bronchus was entirely occluded for a distance of 8 millimeters. Sections cut through the occluded bronchus showed complete obliteration of the lumen.

with granulation and fibrous tissue, in which were interspersed occasional epithelial inclusion cysts. The bronchial cartilages were of a homogeneous appearance and partially degenerated. They were twisted and misplaced occasionally two and three and even four of them lay side by side. The pericartilaginous and peribronchial tissues were fibrous and dense and appeared to have compressed and huddled the bronchial wall and cartilages. The peripheral lung (Fig 4, rt) was atelectatic, appeared congested and oedematous but there was found not the slightest evidence of infection.

A solution of acriflavine in the high concentration used in this work produced quite marked local damage in the bronchial wall with surprisingly little damage to the lung distal to the application or to the surrounding structures. The necrosis is completely aseptic and peculiarly lacking in cellular reaction. The definite fibroblastic reaction in the periphery of the treated area aids greatly in reducing the bronchial diameter by compressing and huddling the bronchial cartilages. Similar aseptic necrosis following the use of other acridine dyes have been described by Milch. Erdheim tested these dyes by injecting them directly into the tissue, and found that peripheral to the zone of destruction there was found a zone of granulation and fibroblastic tissue. The reaction in the case of acriflavine is purely local as the dye is systemically toxic only in large doses and may even be given intravenously without harm.

RESULTS AND DISCUSSION

A series of 44 dogs have been studied following the use of acriflavine by this method. Complete gross and microscopic studies have been made at intervals following treatment. There occurred 11 fatalities in this series the explanation of which shows that in only 2 of these could the solution, as used in our final technique have been at fault. By repeated applications at a single sitting all bronchi to an entire lung have been satisfactorily occluded. This method in our experience has proved surprisingly safe and efficient. In no instance did the collapse of a lung with resultant atelectasis interfere with the animal's

general condition. While intrapleural pressures were not constantly taken, the readings obtained in animals with complete atelectasis showed but little alteration from the pressures in normal animals. This in part may be explained by the very mobile mediastinum present in dogs. The temperature elevation following application was negligible. In dogs, permanent bronchial occlusion caused in some animals a persistent bronchial cough, while in the 3 monkeys in which stenosis has been induced by this method, cough even immediately following treatment was noticeably absent. The human case under treatment at the present time has had a postoperative course marked by the absence of bronchial irritation, cough, temperature, discomfort, physical or X-ray changes in the lung.

The occurrence in these experiments of lobar pneumonia following the production of an atelectasis was not seen. Corvillo (7) has contended that lobar pneumonia, even postoperative bronchopneumonia, is preceded by the production of an atelectasis, and that in this airless lung the pneumococcus infection spreads to produce the typical clinical syndrome. That this theory is not effective in the experimental animal without the intra-bronchial introduction of massive doses of pneumococcus culture, is evident from a study of these protocols. The atelectasis which occurred in the normal animals was unassociated with fever, malaise or loss of weight. Microscopically the airless lung showed no evidences of pneumonitis at any stage (Figs 9 rt, 10 lt, and 11 lt).

CONCLUSIONS

1. A safe and reliable method to produce experimental bronchial occlusion is presented.
2. The theoretical advantages of such a procedure in the treatment of certain forms of pulmonary tuberculosis is considered.
3. Twenty five per cent aqueous acid acriflavine solution as used in these experiments produced an aseptic necrosis of the bronchial mucosa and submucosa, and the formation of a firmly adherent mucoid plug. Later the rapidly regenerating epithelium separated this from the walls and the plug was coughed out. The peribronchial and submucosal tissues

proliferated became fibrosed and occluded the bronchial lumen

4 Pulmonary atelectasis occurred only when all of the bronchi to the lobe had been completely occluded

5 Permanent pulmonary atelectasis even of a whole lung was compatible with the normal health and good general condition of the experimental animal

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THE MECHANISM OF DEATH IN MASSIVE PULMONARY EMBOLISM

WITH COMMENTS ON THE TRENDLENBURG OPERATION

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DEATH from massive pulmonary embolism is such a dramatic incident that descriptions of the clinical picture are commonplace. However, the very fact that the event is so unexpected and tragic has colored the observations with inaccuracies and it is exceedingly difficult to find an adequate clinical analysis of what really may take place. This dearth of knowledge is reflected by the well known discrepancy between the clinical diagnosis of pulmonary embolism and the autopsy findings—perhaps in no other condition do hospital statistics show a greater percentage of error. In many clinics the sole fact that a patient dies unexpectedly and abruptly following a surgical operation gives ample grounds for the diagnosis. One calls to mind the diagnosis of "heart failure" formerly made with such frequency and parallel inaccuracy.

One of the best expositions of the signs and symptoms of pulmonary embolism is to be found in the paper of Gieritz and Crafoord based on a statistical analysis of the clinical picture presented by 27 patients. In 23 instances the condition was correctly diagnosed before death. The symptoms observed were in order of frequency as follows: sudden onset of symptoms without any warning; high soft imperceptible pulse; marked pallor; unconsciousness; slight cyanosis; craving for air; dyspnoea; altered respiration; superficial or deep snatching or groaning; feeling of oppression; dread; anxiety; restlessness; pain or stitch in chest usually over precordium; shock; cold perspiration; pulsations in veins of neck (the authors remark that this symptom is probably more frequent than was noted in the brief accounts available); waving arms about wanting to get up; violent vomiting; strabismus; dilated pupils; giddiness; and yawning also occasionally occur. The symptomatology is summarized as follows: "In

most instances it (massive pulmonary embolism) comes like a bolt from the blue with typical symptoms of which the most frequent are intensive pallor, loss of pulse and consciousness. Common symptoms are also oppression, craving for air and a mild cyanosis with a typical venous pulsation above the clavicles" (1).

It is obvious that the enumerated signs and symptoms represent a composite picture drawn from a group of cases and that in any individual instance many of these findings will be absent. In order to furnish a background for the interpretation of the varying clinical aspects it has been found helpful to define at least 3 mechanisms by which death is produced when a large thrombus is carried through the right heart and lodges in the pulmonary artery. It is evident that the duration of life and the symptomatology will depend upon the amount of obstruction that the embolus produces in the particular case under consideration.

I. COMPLETE OBSTRUCTION WITH IMMEDIATE DEATH

A large thrombus that completely blocks the outflow from the right heart will cause immediate but not instantaneous death from complete cessation of the circulation. The left ventricle continues for a moment to discharge the blood that is already present in the pulmonary circuit and then its output abruptly ceases. There is a loss of consciousness due to cerebral anemia and after a few asphyxial gasps the respiratory center fails completely. The lack of coronary blood supply resulting from the fall of pressure in the aorta increases the dilatation of the right heart already precipitated by the obstruction of the outflow of blood.

It is impossible at the present time to estimate in percentage values just the degree

of occlusion of the artery that is followed by immediate death. In any event it is probable that there exists a wide variation in the response of different individuals due to differences in age, condition of the cardiac musculature, the state of the peripheral circulation and other factors.

II. PARTIAL OBSTRUCTION WITH DELAYED DEATH DUE TO REDUCED EFFECTIVE BLOOD VOLUME

In many cases occlusion of the arterial lumen by the embolus may be so far from complete that the circulation is carried on for some time although under a mechanical disadvantage that ultimately leads to death. It is this type of case that offers an opportunity for pulmonary embolectomy.

For many years, in fact dating from experimental observations by Cohnheim the statement has been made in the literature that if the pulmonary artery be slowly occluded no effects are discerned until a point is reached at which an abrupt failure of the circulation terminates in immediate death. Gibbon, Hopkinson and Churchill showed that this phenomenon was an artifact produced by the experimental methods commonly employed. It was further demonstrated that partial occlusion of the artery produced a period of diminished cardiac output with falling arterial pressure and rising venous pressure. This state of affairs closely simulates the well known effects of cardiac tamponade with the difference that the point of obstruction is in the pulmonary artery rather than at the right auricle or intrapericardial portions of the cavity.

These experimental findings are not infrequently reproduced in the clinic when only a partial obstruction to the flow of blood in the pulmonary artery is produced by the embolus. The following case history is as instructive as an experimental protocol in illustrating this point.

E. S., an obese woman aged 53 years. Following cholecystectomy there was slight fever attributed to minor wound sepsis. No signs of femoral phlebitis were noted. On the fifteenth postoperative day at 3:00 p.m. after the patient had been taken to the laboratory in a wheel chair and returned to bed,

she had a queer feeling in her right chest, like a lump which almost at once developed into a sharp pain. When seen a few minutes later she was lying propped up in bed, pale, apprehensive and laboring for breath. She was retching, nauseated, and bathed in cold sweat. The pulse was rapid and thready. The lips and fingernails were pale and slightly dusky. The blood pressure was 100/60 as contrasted with 150/90 recorded on admission to the hospital. A diagnosis of massive pulmonary embolism was made. Oxygen inhalation was started at once through a nasal catheter and morphine sulphate, 1/5 gram, given hypodermically. Following these preliminary measures the patient was transported to the surgical amphitheater in her bed. Preparations for immediate operation were completed and the patient was kept under constant observation with this in view. The accompanying chart (Fig. 1) shows the subsequent course of events.

During the first hour after the embolism the blood pressure fell steadily. For the next 2 or 3 hours there was little change in the general condition of the patient; the cyanosis was less obvious and the respiration quieter. There were occasional spells of vomiting, retching and stricture of gas, interspersed with intervals of drowsiness. At 9:00 p.m. 6 hours after the onset, the patient's condition was considerably improved. Both systolic and diastolic pressures were higher and the respiratory rate was slower. These encouraging signs persisted for about 4 hours. At 1:00 a.m. 10 hours after the embolism there was a decided change for the worse. The blood pressure fell. Symptoms of air hunger reappeared. The respiration became deep and more rapid and the patient repeatedly attempted to sit up in bed. The anxiety and apprehension of a person dying of hemorrhage were apparent in her face. The patient was placed on the operating table and the operating team made ready for interference.

From this time on the patient slowly lost ground. Her restlessness increased. She attempted to sit up on the operating table, and repeatedly asked for water. The air hunger, the restlessness, the thirst, the low blood pressure with a feeble, rapid pulse and the cold perspiration were remarkably similar to the symptoms that attend a severe hemorrhage. This impression was so vivid that we repeatedly examined the abdomen for signs that might confirm a diagnosis of concealed hemorrhage. There was, however, one striking difference between the picture she presented and that of a patient dying from hemorrhage. *The great veins in the neck became increasingly prominent and a venous pulsation was plainly visible.* Consciousness began to be dulled although the facial expression remained apprehensive and the patient responded to questions. Purposeless movements appeared—plucking at blankets, turning head from side to side. An external strabismus developed.

At 7:04 a.m. venesection was performed. Blood was withdrawn by syringe from a vein in the right ankle. The blood did not flow out under pressure, but was withdrawn slowly and with some difficulty.

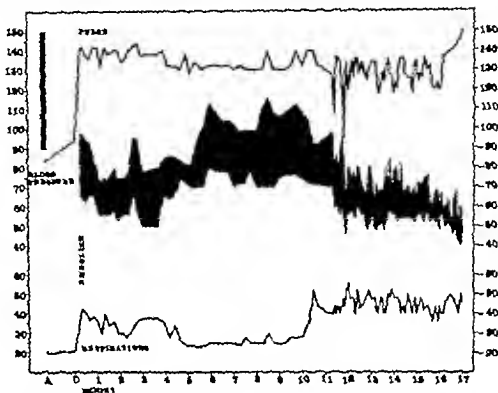


Fig. 1. Clinical chart of patient during the 17 hour interval between a massive pulmonary embolism and death. Systemic blood pressure recorded in solid black, the upper border of which represents the systolic and the lower border the diastolic level in millimeters of mercury.

By 7:37 a.m. 550 cubic centimeters had been withdrawn and citrated in anticipation of reinjection. The patient's condition failed rapidly during this period. The pulse could no longer be counted at the wrist. The blood pressure readings were difficult to obtain and there was considerable decrease in pulse pressure. Examination of the chest at this time revealed that the lungs were resonant anteriorly and laterally. The patient was not turned to examine the back. The breath sounds were harsh but no rales were heard. The area of cardiac dullness was unchanged. By percussion the right cardiac border lay 1.5 centimeters lateral to the right sternal border. The heart sounds were very distant and could be heard only over the third and fourth left interspaces near the sternum. At 8:00 a.m. the blood pressure was 58/42. The pulse rate counted with the stethoscope over the precordium was 150 per minute. The respiratory rate was 48 and the patient was semicomatose. At 8:05 a.m. the blood pressure could not be obtained. One minute later the skin incision was made and the Trendelenburg operation started following in essential details the technique described by Meyer (4). The respirations became gasping with the start of the operation and soon ceased altogether. The pupils dilated. By the time the pericardium was opened, heart action had ceased. Seven minutes after the start of the operation clots had been removed from the main stem and both branches of the pulmonary artery and the opening in the artery had been closed with the

Trendelenburg clamp. Artificial respiration with inhalation of oxygen and carbon dioxide was kept up while attempts to restore the heart action by massage and injections of adrenalin were made. All efforts to revive patient however proved futile.

An autopsy was performed 3 hours later. The great veins contained no blood clots. The coronary arteries were patent. There were no antemortem clots within the heart or main trunk of the pulmonary artery. In the left pulmonary artery about 4 centimeters below the bifurcation of the main trunk there was a grey friable antemortem clot extending down into two or three of the smaller branches of the artery. This clot obstructed only a portion of the artery and was lightly adherent to its wall. The right pulmonary artery was free of antemortem clots except for a small thrombus 1 centimeter long in a superior branch of the artery.

In retrospect and particularly in light of the experimental work already referred to, the mechanism of death in this case seems clear. The initial embolism reduced the output of the right heart and consequently that of the left by mechanically obstructing the flow of blood in the pulmonary artery. The blood backed up behind the site of obstruction filling and distending the venous system. The patient developed the clinical picture of

shock from a reduced effective blood volume. The sympathico-adrenal system was thrown into a state of intense activity with its classic train of symptoms and death supervened as in hemorrhage or other conditions that are attended with an inadequate circulating blood volume. It is quite probable that the high venous pressure with the peripheral stasis that accompanied it resulted in a movement of fluid from the capillaries into the tissues thus further reducing the blood volume.

It is possible that the degree of obstruction produced by the initial embolism was augmented during the succeeding hours by other smaller thrombi or by clot propagation within the pulmonary vessels, but no direct evidence exists on this point.

This case provides a slow moving picture of a series of events that usually follow one another so closely that they cannot be isolated for analysis.

III. PARTIAL OBSTRUCTION WITH DELAYED DEATH IN WHICH RIGHT HEART FAILURE IS A COMPONENT

In descriptions of the Trendelenburg operation it is frequently stated that the pulmonary artery appears markedly dilated when the pericardium is opened. We ourselves have seen it so distended as to impinge upon the under surface of the sternum. Two cases have been encountered however in which the pulmonary artery was collapsed rather than distended although the heart was still beating. As the diagnosis of embolism was verified in each instance this finding can only mean that following an initial insult the right heart was unable to maintain a head of pressure sufficient to distend the artery proximal to the obstruction or that by the time the operation was performed the obstructing thrombus had moved on toward the periphery of the lungs. In either event the patient was dying not of obstruction to blood flow but from failure of the right heart precipitated by the embolus. It seems obvious that the competency of the cardiac musculature to meet the strain of a sudden partial occlusion of the artery may play a real rôle in the mechanism of death. It would be of utmost importance to recognize such a state of affairs clinically as

efforts might well be directed toward the restoration of a dilated and failing right heart rather than toward the removal of an embolus that played an important but transient rôle in the disaster. Just how such a condition is to be recognized except by inspection of the pulmonary artery is difficult to see at the moment. It is planned however should a collapsed pulmonary artery again be exposed to direct the immediate efforts toward restoring the heart by methods other than removing the embolus. This could well be done by a liberal bloodletting directly from the pulmonary artery and the injection of adrenalin with the maintenance of course of an adequate supply of oxygen.

The indication for venesection in the treatment of pulmonary embolism may well be mentioned at this point. If the right heart is dilated and failing then venesection may aid it to recover its competency even with the embolus still *in situ*. On the other hand with an obstructing thrombus in the pulmonary artery and a high head of pressure built up by the right heart that is acting to force blood past the obstruction venesection can only be harmful by reducing this head of pressure. Venous pressure will be lowered it is true but only at the expense of a reduction in what is already a dangerously ineffective cardiac output. So unless a true understanding of the situation can be reached and it is doubtful whether it can be clinically it seems wise to refrain from venesection in the treatment of pulmonary embolism.

THE TRENDLENBURG OPERATION

The surgeon contemplating the performance of the Trendelenburg operation when the occasion may arise must concern himself with many things: prompt and certain diagnosis, an organization for handling the situation as the most pressing of emergencies and finally the technical performance of an exceedingly difficult and specialized procedure.

A great number of failures must inevitably attend the bold attempt to deal with major pulmonary embolism by direct operative interference and there is no doubt that the ultimate solution of this distressing complication of surgery must be found in the preven-

tion of the initial postoperative thrombosis. However, lives have been saved by the operation and until our knowledge of preventive measures is more perfect the surgical treatment of pulmonary embolism must command attention. The recent revival of interest in the Trendelenburg operation for massive pulmonary embolism followed the report of a successful case by Kirschner in 1924. Within a short time accounts have been published of other cases in which the operation was a life saving measure. Meyer, Nyström, Crafoord and other European surgeons have successful cases to their credit but to date no survivals have been reported from America.

Many well considered modifications of the original technique have been suggested by Meyer and by Nyström and we may look forward to further suggestions as the operation is taken up by other hands.

It is not our privilege to discuss the technical features of the operation on the basis of unsuccessful cases but we venture a few comments, some of them merely in corroboration of the suggestions of Meyer or Nyström.

1. Opening the pleural cavity is an error of technique to be carefully avoided.

2. Given time development of the skin flap with resection of the ribs and costal cartilage and ligation of the internal mammary vessels may suitably be done under local anesthesia as a preliminary step.

3. The original Trendelenburg sound is needlessly large and clumsy; the clamp for closing the artery far too crude. Modified instruments have been found more suitable.

4. Fragments of emboli that cannot be grasped by the forceps can be removed from the artery by a suction tube.

5. An apparatus for carrying on artificial ventilation with oxygen under positive pressure should be at hand, preferably an intratracheal insufflation cannula as devised by Flagg.

Although our enthusiasm is somewhat dampened by a series of 10 failures, we shall continue to recommend the Trendelenburg operation under favorable circumstances. The following facts are beld constantly in mind: (1) Certain patients rally from the initial effects of embolism and eventually recover

from what was apparently a moribund condition (2) Death may be impending from right heart failure initiated by an embolus; the mechanical effects of which have been transient (3) Diagnosis is difficult (4) The operation is technically difficult and hazardous.

Nyström wisely advises the postponement of operative interference until the patient is at the point of death. When uncertainty exists as to the diagnosis and prognosis this is undoubtedly the course to be pursued. It is obvious however that in the face of the gross damage to the circulation produced by a massive embolus any unnecessary delay will materially lessen the chances of success. A study of the clinical course of certain patients has emphasized this point, for certainly at times in our hands the procedure could perhaps be more properly termed an immediate postmortem examination than a surgical operation. If the time of the operation is to be advanced a greater responsibility is to be assumed by the surgeon and a greater surety in diagnosis must be developed. With this in view an effort has been made both in the clinic and the laboratory to gain a better understanding of the nature of the underlying disturbance of the circulation. When such a concept is clearly established the signs and symptoms observed at the bedside become more intelligible and the indications for operation more readily discerned.

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UNATTACHED RETROPERITONEAL FIBROMA¹

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REPORT OF A CASE

THERE is prevalent among many medical men an impression that the majority of retroperitoneal tumors, unless growing from or involving the kidney are sarcomata. The fact that many of the patients suffering from retroperitoneal tumors lose weight very rapidly the decline of the patient being synchronous with a period of rapid growth of the tumor further adds to this conception. As a result a large number of patients afflicted with the disease are either not treated surgically or if treated are too frequently condemned by the operating surgeon for lack of understanding of the true nature of the tumor.

My experience during the past few years has led me to believe that a considerable number of retroperitoneal tumors are not sarcomata and that their removal is possible although at times fraught with considerable hazard because of their size. I have had the opportunity to see 5 cases within a period of less than 2 years. One was a pure lipoma, 1 an enormous fibrolipoma weighing 64 pounds, 1 a pure fibroma, 1 an echinococcus cyst the size of a medium sized grape fruit and 1 a sarcoma. In all these cases the patients were operated upon and 3 were cured. The case with the large fibrolipoma and the one with the sarcoma came to autopsy soon after exploration.

The opportunity thoroughly to study the case presenting the fibroma dura leads to the presentation of the subject.

F. L. C. white male aged 31 years, came under observation on October 16, 1932, complaining of an enlargement of the abdomen. The family history, habits, and the marital history were negative. There was nothing in the past history of consequence except an automobile accident in 1928 at which time he suffered a bilateral fracture of the clavicles.

Approximately 5 years ago patient first noticed attacks of fullness in the abdomen which he attributed to gas in the intestines. These attacks were of little consequence and came at intervals. One year ago he began having attacks of abdominal cramps which affected the upper abdomen. They occurred practically every day, were irregular as to the time of appearance, and did not seem to be associated with

the taking of food although they were more likely to occur after meals. The cramps were at times relieved by a bowel movement or the passing of flatus. Soda or alkalies did not relieve the pain, and he noted that the taking of more food increased the pain rather than relieved it. His bowels were, as a rule, constipated and the stools were frequently hard. He had never been jaundiced and the appetite was good. There was no discomfort with urination. About 6 months before entering the hospital he first noted a tumor mass in the left side of the abdomen. Upon close questioning the patient stated that he thought the left side of the abdomen had been more prominent the past 3 or 4 years but he paid little attention to this fact. However during the past 6 months there had been a distinct and progressive enlargement. During the period of 2 or 3 months before entering the hospital he was much annoyed by the abdominal distention which caused him shortness of breath when lying down or when exerting himself; moreover the pain had been more severe and frequent and distinctly of a cramp-like nature. Any constriction such as a belt about the abdomen was uncomfortable. He perspired at night, became very nervous, and tired easily.

Physical examination. The general examination revealed an adult white American male about 32 years of age who did not appear to be critically sick. He was somewhat ill at ease and apprehensive. Temperature was 97.6 degrees, pulse, 72 and respirations, 16. He weighed 153½ pounds. His highest adult weight was 171 pounds in 1919 and lowest 147 pounds in 1926. His weight 2 years before was 160 pounds. The physical examination aside from the abdomen was negative except for some infected teeth, slight nasal obstruction, and a moderate enlargement of the thyroid gland.

The abdomen was quite protuberant but no dilated veins could be seen in the abdominal wall. There could be felt a firm, rounded, fairly regular mass which occupied the left side of the abdominal cavity and extended to the right side of the abdomen for a distance of 3 inches at the level of the umbilicus. Its lower margin crossed the midline about 2 inches below the navel and extended well down into the left lower abdomen. The flank on the left side was bulging but the protuberance was more anterior than posterior. The mass had no respiratory excursion, being fixed and extending high up under the costal margin. Along the anterior right surface of the tumor could be felt a notch. Crossing the anterior surface of the tumor there could be felt a sausage-like mass which had slight mobility and gave one the impression that it was the transverse colon. The spleen and liver could not be palpated.

Rectal examination was negative. No enlarged lymphatic glands could be palpated and there was no edema of the extremities or scrotum.

Laboratory data. The electrocardiogram was essentially normal. Two Wassermann tests were negative. Five urinary examinations failed to reveal any pathological findings. The red blood cells numbered from 4,120,000 to 4,710,000; leucocytes from 6,700 to 8,300; haemoglobin 80 to 85 per cent. The differential white count was within the normal percentages. No pathological cells were found. The coagulation time of the blood was 3 minutes. Blood non-protein nitrogen was 30.9, creatinin 1.6 and blood sugar 92.3. Examinations of three specimens of feces showed no blood, mucus, parasites, ova, or protozoa. Fractional gastric analysis revealed a low acidity, the free acid ranging from 0 to 12 and the combined acid from 10 to 24. Blood was reported in one specimen. The urine dilution and concentration tests were within the normal. Thirty per cent of the dye was eliminated in 2 hours.

A roentgenological examination of the gastro-intestinal tract showed that the barium passed the oesophagus without resistance. The stomach was on the right side and was pushed over almost to the right lateral abdominal wall (Fig. 1). The curvatures were regular. The duodenal bulb filled and showed no evidence of abnormality. The small bowel was displaced to the right and downward so that the left side of the abdominal cavity appeared to be empty. The colon with a barium enema revealed the splenic flexure at the level of the crest of the ileum, the transverse colon coursing abruptly to the right and ascending to the right of the spine (Fig. 2). A 5 hour film showed a small gastric residue (Fig. 3). Pyelography with the intravenous dye revealed a normal kidney pelvis on the right side but none was visible on the left side (Fig. 4). Roentgenological examination following retrograde pyelography revealed a normal right kidney but on the left side the catheter passed upward to the level of the third lumbar vertebra. At this point it took a sharp bend to the right and proceeded downward along the right side of the spine. The injection of the left kidney pelvis showed a dilated pelvis overlying the intra-vertebral disc between the fourth and fifth lumbar vertebrae and in the right of the spines of the vertebral bodies (Fig. 5). It was evident that the left kidney was pushed downward and to the right by a mass occupying the left retroperitoneal space. The same mass displaced the stomach to the right and the intestines downward and to the right.

A brief summary of the study of this case revealed the following: A large abdominal mass which displaced the intestines and the kidney downward and to the right. This mass had been present for 6 months as far as the patient knew but had caused symptoms, if the history is correct for approximately 5 years. The mass was fixed and large. There were no other physical findings of note except an enlarged thyroid gland. The patient's general condition was good although he had lost some weight.

There was no evidence of a cachexia. The blood and urine were normal.

An enlarged spleen was ruled out on the basis of the displacement of the left kidney, and, because of the peculiar and characteristic shifting of the gastro-intestinal tract the tumor was believed to be retroperitoneal. With the long history of symptoms and the relatively good condition of the patient the tumor was believed to be a benign one and a diagnosis of retroperitoneal lipoma was made because of the relative frequency of this type of tumor among the retroperitoneal group.

The patient was operated upon November 9, 1932, under spinal anesthesia. An incision was made extending from well out in the left flank, transversely to beyond the midline 1 inch above the umbilicus. The muscles were sutured to their fascia as they were cut. The peritoneal cavity was opened at the reflection of the peritoneum along the anterior surface of the tumor. The spleen was normal in size and pushed high up under the diaphragm. An accessory incision was made upward from about the middle of the left rectus muscle to the costal margin giving an adequate exposure. The posterior peritoneum with the descending colon was separated from the tumor by blunt finger and hand manipulation. The tumor appeared to be smooth and rather loosely attached to the surrounding structures so that it could be separated quite easily. Because of the enormous size of the tumor it had to be enucleated blindly, the hand being introduced around it. At the upper pole of the tumor the procedure was quite difficult because of the tight compression of the tumor against the diaphragm, however with care and without force the line of cleavage being followed the tumor was finally completely freed. In spite of a very large incision and with good relaxation of the abdominal wall the tumor had to be pried out at the lower pole and then, being grasped, it was withdrawn. When the tumor was delivered it was found that a strand of loose areolar tissue containing two veins which were approximately one half inch in diameter led from the posterior peritoneum to the tumor. These veins were ligated and cut, thus completely freeing the tumor. It was interesting to note that the veins did not course over the surface of the tumor but emerged from the tumor by a sharp right angle turn without any surface contributions (Fig. 6).

The right kidney was found lying low in the abdominal cavity but it readily assumed its normal position. In fact all intra-abdominal structures resumed their relatively normal positions so that before an attempt was made to close the incision the enormous cavity which had been occupied by the tumor was completely obliterated. After a few small vessels were ligated the field of operation seemed dry. The incision was closed by interrupted catgut sutures and, strange to say, some difficulty was encountered because of tension. A Penrose drain was placed in the lower end of the wound. The early convalescence was uneventful and there was little

drainage. Twelve days after the operation the patient began complaining of pain in the left lower chest and the left upper abdomen and a slight fever was present. Upon examination an area of dullness was found in the left lower chest. It appeared that there was either an accumulation of fluid in the left pleural cavity or the diaphragm was pushed up by some process. A roentgenological examination was interpreted as some process elevating the dome of the diaphragm on the left side. A cautious exploration was made of the left subphrenic space but no evidence of subphrenic pathology could be found. A needle was then introduced into the left pleural cavity and dark bloody turbid fluid was aspirated. This fluid yielded a positive culture of *Staphylococcus albus*. A rib resection was done and drainage was instituted. Subsequent to this with lavage of the intrathoracic cavity the fluid escaped through the abdominal wound indicating a perforation of the diaphragm. The process gradually subsided so that within a period of a month the wound was practically closed. The patient gained materially in weight and felt quite well. We are unable to explain the perforation of the diaphragm.

A study of the tumor showed it to be well encapsulated. Its surface was relatively smooth and there were no vessels coursing over the surface. It was firm to touch. It measured 35 centimeters in length and 63 centimeters in circumference and weighed 16 pounds (Fig. 7). On cut section the surface was found to be white and firm with no areas of degeneration. Microscopically the tumor was everywhere composed of long spindle shaped cells with slender deeply staining nuclei and relatively little cytoplasm (Fig. 8). The microscopic picture varied somewhat in different parts of the mass. In places the nuclei were few in number and the cells were separated by thick wavy fibrillae which stained deep red with Van Gieson's, and dark blue with Mallory's aniline blue stains (Fig. 9). Scattered through the sections were areas in which the cells were more numerous and the intercellular substance less abundant (Fig. 10). In other locations the cells were separated by spaces filled with thin homogeneous, very pale staining material—edema (Fig. 11). Blood vessels were not numerous and their walls were well formed and normal in appearance. No mitoses and nothing that could be identified as nerve tissue could be found in the sections.

This tumor is therefore a pure fibroma growing in the retroperitoneal space and because of its loose attachment can be classed as unattached.

In discussing the subject of retroperitoneal fibroma those tumors obviously arising from the kidney, adrenals, or the retroperitoneal lymph glands either primarily or secondarily as metastases will not be considered. However the benign tumors such as lipoma, fibromyoma, neuroblastoma, teratoma, and cysts must be included because of the simi-

larity of the clinical symptoms and the question of the origin of the tumor.

ETIOLOGY

According to Ewing the origin of most fibromata is still a question. He believes it possible that some take their origin in misplaced islands of tissue as suggested by Cohnheim and calls attention to cases of fibroma of the testes in which elements suggesting that the tumor represented a one sided development of a teratoma were found. This latter suggestion has a close bearing upon retroperitoneal fibromata as will be mentioned later in this paper. Ewing mentions a second group which may follow local irritation or disturbances in nutrition. In this group may be mentioned keloids, papillary fibromata and adenofibromata of the mucous membranes associated with catarrhal inflammation and fibromata of the periosteum and joint areas which follow repeated trauma. In the third group, according to Ewing the clinical features point to a congenital or acquired predisposition, multiple neurofibroma being the best example.

The mixed nature of most retroperitoneal tumors strongly suggests an origin upon a congenital rest basis. Moreover the frequency of tumors such as teratomata and dermoid cysts in this region further strengthens the theory. Bonnet directs attention to the close relationship between various mixed tumors, embryoma, dermoid teratoma, and abortive parasitic structures and concludes that the difference is more a relative matter than one of principle.

When one considers the embryological relationship of the retroperitoneal structures it becomes apparent that the theory of Bonnet and Marchand is not far fetched. Kuester in his book on the surgery of the kidney states that in the latter part of the second month of the human embryo the entire space between the diaphragm, pelvis, and the spine is occupied by the adrenals, kidneys, and reproductive glands. The adrenals and reproductive glands are so large as to cover the kidney completely. While the kidney remains in its position and increases in size the adrenals take a higher position and increase little if any in size. With the increase in the length of the body the

reproductive glands begin their descent—not increasing in size as rapidly as do the kidneys—and become differentiated into testes and ovary, by the fifth month they lie in the inlet of the pelvis well out of the original zone. Goebell states that during the re-arrangement of these organs parts of the adrenals or reproductive glands may become detached and remain in the retroperitoneal space. Accessory ovaries have been found and Wiesel states that in 76.5 per cent of the male newborn accessory adrenals or epididymal structures are to be found. In the amphibians, accessory adrenals are exceedingly common.

Schwalbe cites two possible explanations for tumor formation from retained fetal structures. The retained cells have the prospective potential and the prospective tendency to form tumors. He cites as an example of the biological principle, the inactive tooth anlage in the fetus which lies dormant for from 6 to 25 years having during this time the potentialities to form a tooth. Secondly the retained cells have the potential to form only a tumor and remain latent. At some time through either chemical or physical stimuli they may become activated and form tumors.

There is an evident possibility for the tumor to be originally of a mixed type and later due to either an overgrowth of one type of tissue due to its inherent tendency to grow or to a stimulus of some other nature it may take on the cellular characteristics of a pure tumor. The specific original cells may supply the stimulus to growth.

In the case reported the tumor derived its blood supply or at least drained its blood supply through vessels attached to the posterior peritoneum, therefore it may be postulated that the tumor originated in some tissue elements of the peritoneum. It is known, however, that the tissue lying between the leaves of the mesentery and the broad ligaments was originally retroperitoneal tissue, therefore a residuum may have been carried into the mesentery along with the blood vessels or the blood vessels of the cell rest may have been carried into the mesentery, thus accounting for the anatomical picture.

Neurofibromatosis offers a condition which must be of interest to any one who concerns

himself with the etiology of tumors, especially fibromata. According to Kaufmann, the condition is conceded to be on a congenital basis. There is a distinct pattern in the constitutional manifestations, anomalies in the osseous system and disturbances of intelligence are common and the tendency to form fibromata, myxofibromata and sarcomata is present. Kaufmann states that the disease usually manifests itself first by the presence of skin pigmentations and skin tumors. Frequently pigmented skin anomalies as well as pale naevi adenomata of the sebaceous glands of the face and all types of naevus-like growths are present. Brain lesions often appear in the wake of this pattern and tumors of the nerves as well as tumors of the gastro-intestinal tract may follow. These tumors which may arise on a congenital basis are a part of the clinical picture of neurofibromatosis and are of interest because of the close resemblance to true fibromata. Grossly they are practically identical and microscopically they can at times be differentiated only by special stains, in fact, Kaufmann states that pure fibromata may grow from either the perineural or endoneural connective tissue. Verocay believes that the tumor consists of a structure the result of a multiplication of the cells of Schwann and that it is not connective tissue since it does not stain red by Van Gieson stain, on the contrary it takes a yellow stain.

In 1932 Hausmann and Budd reported a series of 17 cases of massive unattached retroperitoneal tumors of urogenetic origin. In this series there was no case of fibroma but two fibrosarcomata. Our attention was drawn to the fact that they reported 2 cases of retroperitoneal chorio-epitheliomata both in males. They stress the urogenetic fetal rests and conclude from their own experience and from evidence obtained from the literature that almost all tumors which occur in adult urogenital organs may occur free along the course of development of the urogenital apparatus and that these free tumors arise from remnants of the urogenital apparatus is the most logical explanation of their histogenesis.

The theory of Ewing relative to the origin of fibromata in general can be applied to retroperitoneal fibromata. Misplaced islands

of tissue the cells of which possess the potential to growth may lead to tumor formation moreover specific cells such as epithelial cells may by their presence or due to the products of their metabolism stimulate the connective tissue to localized growth much as an irritation produces fibromata of the mucous membranes. When the process is once activated the primary cells may become inactive or disappear and the process may continue to the formation of large tumors of a secondary type

CASES IN THE LITERATURE

Cases of pure retroperitoneal fibroma are extremely rare. In 1901 Goebell in searching through the literature was able to find reference to only 7 cases. Of these several are questionable as example the first case which was reported by Beveridge. The original report published in 1870 includes no microscopical examination but it was stated that the growth was suspiciously a neurofibroma. Buschmann's case was a fibromyoma and the one reported by Bruntzel a fibrolipoma. Moericke's case appeared to be a fibrous tumor but no microscopical examination was included in the report. In one of Joubert's cases no microscopical examination was made. Since 1901 I have been able to find the report of only 4 cases of pure retroperitoneal fibromata. Child in 1913 reported the removal of a fibroma with myxomatous areas weighing 14.75 pounds. Graham in 1916 removed a fibroma the size of a large grape-fruit but stated that the tumor was attached to the colon which necessitated a bowel resection. This was most likely a myofibroma of the type described by me in 1928 under the topic of *Leiomyomata of the Intestines*. Magoun in 1919 reported from the Mayo Clinic that during the period from 1907 to 1919 among 73 non-metastatic retroperitoneal tumors, 1 fibroma was encountered. Ogilvie in 1923 reported from the clinic of Rowlands an instance of a tumor $2\frac{1}{2}$ by 4 inches removed from retroperitoneal space. Microscopic examination showed it to be a fibroma with much necrosis. Several suspicious cases in the literature lack microscopic verification.

A relatively large number of benign retroperitoneal tumors of other types are reported

in the literature. In 1910, Vegesack in searching the literature found reference to 58 cases of pure lipoma and added one of his own. He found an additional 50 cases of mixed benign tumors. Of this series 74.2 per cent were in females and 25.8 per cent in males. In 1921 von Wahlendorf tabulated 153 proved cases of benign retroperitoneal tumors. 72 per cent were in females and 28 per cent in males. Of the total number 46 per cent were pure lipomata and 54 per cent mixed tumors. Of the mixed 20 per cent were fibrolipomata, 10 per cent myxolipomata, 10 per cent fibromyxolipomata, and 14 per cent showed evidence of early sarcomatous changes. In 1932 Bettman and Serby reported the removal of a retroperitoneal lipoma weighing 22.5 pounds and Koch recently removed a very large lipoma. The common tumor is of the mixed type often with myxomatous changes. Ganglioneuromata have been reported and various cysts and teratoma like tumors are encountered.

SYMPTOMS AND SIGNS

The symptoms produced by the various types of benign retroperitoneal tumors are quite similar. They depend upon the location of the tumor whether the tumor is large or small and whether it is growing rapidly. In a large percentage of cases the earliest symptom is a vague sense of weight and distress in the abdomen. The distress may be present for a considerable period of time extending at times over a period of years, as is illustrated in the case just reported. The distress may bear a relationship to the intake of food, the bowels may be irregular and the discomfort is often attributed to faulty elimination. Cohn states. The symptoms caused by a retroperitoneal growth are dependent on the location of the growth. Proximity to the coeliac plexus causes digestive phenomena whereas growths even of larger size in other locations may not cause digestive disturbances. The dyspeptic symptoms present in many cases are often transitory and do not appear to be produced alone by pressure. In the instance reported by Child in which a tumor weighing 34.75 pounds was removed he states. Bilious attacks and constipation formerly complained of disappeared with the growth of the tumor.

Pain sooner or later makes its appearance. It may be produced in a number of ways and be variable in character and location. Pressure of the tumor upon the intestinal tract may produce cramp-like abdominal pains suggestive of incomplete intestinal obstruction. A referred pain may be an early symptom. This pain which is referred to the leg or foot or to the testicle on the affected side is due probably to compression of the nerve trunks of the lumbar or sacral plexus. Stratton called attention to this phenomenon in his case in which a very large fibromyxoma with sarcomatous changes was removed. The pain was referred to both the leg and testicle on the affected side. Bruntzel also reported that his patient began having pain in the foot and thigh on the affected side when the tumor began growing rapidly. A type of pain suggestive of obstructive hydronephrosis may be present. In one case reported by Goebell the decrease of urinary output of the patient was associated with severe pain on the affected side. Increase of urinary output was synchronous with relief or amelioration of the pain. Bladder pain may be present when the tumor lies deep in the pelvis and compresses the bladder.

Oedema of the penis or the extremity of scrotum on the affected side is constantly referred to in the literature. In his report Beveridge stated that the first symptom noted in his case was a swelling of the right leg and thigh. A month later an enlargement of the abdomen was observed. In the case reported by Johnson the swelling of the scrotum was more marked at night. Goebell, Douglas and others stress the importance of the unilateral oedema and believe it due to pressure of the tumor upon the vena cava. Cohn believes that a right sided growth readily produces oedema whereas a left sided lesion may not be associated with oedema of the extremities. In my case there was no oedema present during the period of observation nor was there a history of oedema. If the oedema is caused by compression on the vena cava its absence in my case can be readily explained because of the position of the tumor on the left side with the vena cava and pelvic vessels comparatively unmolested.

Occasionally urinary symptoms are encountered. This symptom is usually present when the tumor lies low in the abdomen or becomes wedged in the pelvis. Stratton's second case quite early in its course presented pain and pressure symptoms referable to the bladder with frequency and burning. As referred to previously symptoms suggestive of hydronephrosis may be present. Goebell noted in 1 case a variable daily urinary output suggestive of obstruction. It is instructive to note however, that in most of the cases of benign retroperitoneal tumors even when very large, the urine was normal.

Retroperitoneal masses may be associated with a chylous ascites and chylous pleural effusions as cited by Cohn in his case.

Very commonly benign retroperitoneal tumors possess irregular growth. They may grow slowly for a period of years and then suddenly increase in size very rapidly. This phenomenon does not mean, of necessity, a malignant change. It was present in my case. Bruntzel, Beveridge and others have called attention to this phenomenon in reporting cases of benign retroperitoneal tumors. No doubt a hemorrhage into the tumor or types of degeneration may bring about a rather sudden enlargement. The progressive and rapid enlargement of the tumor is associated, in practically every instance with a decline in the patient's general condition. Weakness, loss of weight, malaise, and an anemia may supervene. A sallow skin suggestive of a malignant cachexia may be present. In the late stages the general decline of the patient's health predisposes him to intercurrent infection or fatal nutritional disturbances.

PHYSICAL FINDINGS

The physical findings will vary with the size and location of the tumor. Early when the tumor is small it is easily overlooked since the symptoms may be referred to a distant part of the body and may in no wise indicate the true nature of the disease. In the majority of cases a tumor will be found lying deeply in the abdomen. It is usually movable more in the transverse than in the vertical plane of the body. As the tumor increases in size it tends to become fixed. Lipomata are often irregular in

contour and may be soft in consistency. Some may be soft and give to the palpating finger the sense of fluctuation. In several cases reported a diagnostic puncture had been made in the belief that the tumor was a cyst. No less a master than Billroth was confused by such a case. Not all lipomata are soft, however. The fibroma is usually rather firm and resistant to pressure and is more likely to be smooth as was true in the case just reported. The diaphragm may be pushed upward and immobilized by the tumor when the latter lies high in the abdominal cavity. Displacement of the abdominal viscera is invariably present when the tumor attains large dimensions. The displacement varies with the location of the tumor and especially with the site of origin of the tumor. The intestines, as a rule, are pushed forward and downward and then to the opposite side as seen in my case. If the tumor takes its origin above and behind the kidney this organ will be pushed downward or to the opposite side. Mathews reported a case giving no symptoms except an enlargement of the abdomen. The spleen was displaced upward and the kidney was pushed forward so that it lay in contact with the anterior abdominal wall. In the case reported by Baxter a tumor on the right side displaced the right kidney to the left of the spine, the kidney being rotated on its axis so that the pelvis of the kidney faced to the right. In this instance the kidney was completely embedded in the tumor. Opaque material in the gastrointestinal tract and the genito-urinary system with roentgenological study gives invaluable information in localizing the tumor. It should be stressed that in every instance of retroperitoneal tumor a thorough study should be made of both kidneys since it happens at times that the kidney on the affected side may be involved in the tumor necessitating its removal.

When the tumor reaches a very large size so as to fill a good share of the abdominal cavity its origin or point of primary attachment cannot be determined. In my case the tumor occupied almost the entire left side of the abdominal cavity and extended to right side. It was assumed that it took its origin in the region of the upper pole of the left kidney since the left kidney was carried down to the

pelvic inlet. Since the kidney function on the affected side was normal it was assumed that the tumor did not involve the kidney substance. Such large tumors are difficult to outline or define. They become fixed due to lack of space and impingement against the spine, abdominal wall and the diaphragm.

DIAGNOSIS

The diagnosis of retroperitoneal tumors is difficult in many instances. When the tumor is small the posterior position with rather free movability is suggestive yet intraperitoneal tumors may possess this characteristic. The majority of errors involve ovarian cysts, tumors of the kidney, retroperitoneal sarcoma and splenic enlargements. The kidney can in most instances be eliminated by a careful functional study with intravenous or retrograde pyelography, moreover most kidney tumors sooner or later present pathological urinary findings. Splenic tumors are more difficult to differentiate. In my case a diagnosis of splenomegaly had been made prior to admission to the hospital. A careful examination of the physical characteristics of the tumor and blood studies should, in the majority of instances, make the differentiation. A splenic tumor will not displace the left kidney. Large ovarian cysts or tumors and pedunculated uterine fibroids may be confused with retroperitoneal tumors. These tumors are more movable than retroperitoneal tumors which extend into the pelvis, and it is often possible to ascertain a point of attachment to the pelvic adnexa.

Such tumors as mesenteric cysts, tumors of the omentum are difficult to differentiate from retroperitoneal tumors. A carefully conducted roentgenological study of the gastro-intestinal tract will not reveal the characteristic displacement of the intra-abdominal organs; neither will the kidneys be displaced. Cysts of the pancreas are more fixed and have a tendency to protrude anteriorly.

Retroperitoneal sarcoma is the usual diagnosis made in the presence of a benign tumor. Early in its course this type of tumor is often encapsulated and movable. It grows rapidly but no more so than does a benign tumor. The one referred to early in this paper was present



Fig. 1



Fig. 2



Fig. 3.

Fig. 1: Roentgenogram showing the displacement of the stomach to the right and anteriorly and the small bowel downward and to the right.

Fig. 2: Roentgenogram showing the displacement of the colon. The splenic flexure is below the iliac crest and

the transverse colon courses to the right and upward.

Fig. 3: Roentgenogram showing a small 5 hour gastric residue also the displacement of the small bowel to the right and downward. This film also shows an opaque ureteral catheter in the left ureter.

in a well nourished individual, there had been no loss in weight and subjective symptoms were practically absent. These factors led me to make a diagnosis of a benign tumor.

Buettner stressed three points in the diagnosis of benign retroperitoneal tumors: (1) the exact location where the tumor was first noticed, (2) whether there is a connection with the genital organs, (3) the topographic displacement of the intestines.

TREATMENT

A study of the literature indicates that the diagnosis of benign retroperitoneal tumor is rarely made, however with careful study I believe that in a considerable number of cases the tumor may be recognized or at least a strong suspicion may be aroused. New methods of study and an understanding of the condition will lead to more correct diagnoses. It is my firm belief that all cases of abdominal tumors should be explored in spite of size, location or preconceived ideas relative to the nature of the tumor. A comparatively small tumor may produce symptoms which strongly suggest a malignant process.

However, in spite of the suggestion, an attempt should be made to determine definitely the nature of the process and an equally intelligent attempt should be made to remove it if advisable. The very large benign tumors carry a high mortality rate when operated upon yet, in many instances, removal has been carried out with little operative reaction.

In my case spinal anesthesia was used because of the relatively good condition of the patient and with the knowledge that relaxation of the abdominal wall would be an invaluable asset. The type of incision will depend upon the size and location of the tumor. In the presence of a large tumor, the transverse incision with an accessory vertical incision gives good access to the retroperitoneal space. The counter incision may be carried upward or downward or both as needed. Suture of the muscle fibers and material assists when the closure is done. In my case the peritoneal cavity was deliberately opened in order to determine the anatomical situs of the tumor, since a splenic tumor was suspected before the final diagnosis was made.



Fig. 4, left. Roentgenogram taken after an intravenous injection of skodan. The pelvis of the right kidney appears normal, the left is not visualized.

Fig. 5. Roentgenogram showing a catheter in the left ureter with an injection of the pelvis of the displaced left kidney. The pelvis lies to the right of the posterior spinous processes, the center overlying the interspinous space between the fourth and fifth lumbar vertebrae.

In most instances the tumor is well encapsulated. Therefore if the line of cleavage is found the enucleation is easy. However gentle separation must be insisted upon because blood vessels usually veins of great size may enter the tumor and should such large vessels be torn in an inaccessible region such as behind or at the upper pole fatal hemorrhage may ensue. The case reported by Buschmann which was operated upon by Billroth seemed cystic, so a trochar was inserted to evacuate the fluid. Profuse bleeding followed and it was later discovered that the trochar punctured one of the large veins

which coursed over and through the tumor. Some of the veins were as large as the collapsed small bowel. In Beveridge's case the right iliac vein was completely involved. As was mentioned earlier in this paper the kidneys should always be studied relative to their individual function since at times it becomes necessary to remove one when it is involved in



Fig. 7. Photograph of the tumor, a pure retroperitoneal fibroma weighing 16.5 pounds. It measured 32 centimeters in length and 65 centimeters in circumference.



Fig. 6. Drawing illustrating the manner in which the veins made their exit from the tumor.

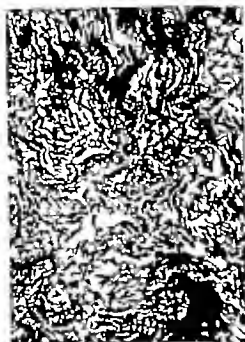


Fig 8



Fig 9



Fig 10

Fig 8. Photomicrograph showing the long spindle shaped cells characteristic of a fibroma. $\times 150$.

Fig 9. Photomicrograph showing few nuclei and the thick wavy fibrillae which stained deep red with Van Gieson's and dark blue with Mallory's aniline blue stains. $\times 310$.

Fig 10. Photomicrograph of an area of the tumor where the cells are more numerous and the intercellular substance less abundant. $\times 310$.

the tumor. In Bruntzel's case the tumor was attached to the left kidney necessitating its removal. Childe was able to strip the tumor from the kidney, to the capsule of which it was attached. Koch recently had to remove the kidney because it was involved in a large lipoma.

Occasionally the tumor has a pedicle of some size which requires section. This pedicle should be brought into view, clamped, and cut. Blunt blind tearing may cause damage to important structures or lead to profuse, often fatal, bleeding. Great care should be exercised in separating the posterior peritoneum from the tumor for fear of injuring the blood supply or continuity of the bowel. In my case there was a loose areolar connection between the tumor and the posterior peritoneum; the thin filmy tissue containing two very large veins. This attachment was not visualized before displacement of the tumor, yet it could be felt during the process of enucleation. This incidence again emphasizes the necessity for care in the process of enucleation of the tumor.



Fig 11. Photomicrograph showing the cells to be separated by spaces filled with thin, homogeneous, very pale staining material (oedema). $\times 310$.

All bleeding or oozing points should be carefully ligated to prevent the formation of a haematoma. In most instances with the trauma due to the removal of the tumor there is a considerable fall in the blood pressure. The reactionary rise may take place soon after the conclusion of the operation and extensive bleeding may ensue. In my case it was interesting to note the tendency of the organs to assume their normal position after the removal of the tumor. The left kidney which was at the inlet of the pelvis immediately moved upward and to the left, the bowel pushed the posterior peritoneum to the left so that the large space was apparently com-

pletely obliterated in fact some difficulty was encountered in closing the abdominal incision. Nevertheless, I believe that drainage is desirable. Complete hæmostasis cannot be secured and a retroperitoneal hæmatoma is likely to become infected. The encapsulated empyema complicating my case has not been explained nor could the perforation of the diaphragm be satisfactorily explained.

The prognosis in benign retroperitoneal tumors must be a guarded one. Many authors stress the frequency of secondary malignant manifestations. This applies especially to large dissecting lipomata in which parts of the tumor are not removed, and to mixed tumors such as lipomata and fibromata with myxomatous degeneration. In his work on the peritoneum Hertzler states: Lipomatous tissue is often intermingled with myxoid and the latter is always closely related to sarcoma. It is the tendency to admixture that removes them from the usual class of histoid tumors. Inadequate examination of large tumors may lead to an erroneous diagnosis relative to the presence of malignant changes. In a series of 113 cases of benign retroperitoneal tumors operated upon von Wahlendorf reported 15 recurrences and 60 (54 per cent) cures.

The operative mortality depends to a considerable degree on when the operation is done in relation to the size of the tumor. The comparatively small retroperitoneal tumor can be removed with little danger as to life; however very large tumors are difficult to remove and according to Vegetack the operative mortality approaches 38 per cent. In the 113 operations reviewed by von Wahlendorf there were 29 (25 per cent) deaths during or shortly after operation. The pre-operative preparation of the patient, the judgment exercised in the selection of the anesthesia, the nature and size of the tumor and the surgeon's ability are important factors which control the mortality rate.

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SOME REMARKS ON THE OPERATIVE PROCEDURES FOR APPENDICITIS¹

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THE widespread interest in the mortality of appendicitis has prompted us to make a careful study of over 3000 cases² which have been operated upon in the Cincinnati General Hospital. In accord with the published reports of others this study revealed that delay in operating and the use of purgatives were the principal factors in the unnecessary sacrificing of lives. Yet there was a certain other factor having to do with the operative procedure which seemed to us to be significant. A short discussion of this factor together with a description of two points of technique which appear to make the operation of appendectomy safer and simpler is dedicated along with the author's admiration and affection to Dr. Allen Kanavel.

From 1915 to 1922 operations for acute appendicitis in the Cincinnati General Hospital were performed through a right rectus incision. During this time 409 cases of acute appendicitis were operated upon and the mortality rate was 9.8 per cent.

Early in 1922 the McBurney incision was adopted for acute appendicitis and has been exclusively used since then. Sixteen hundred and twenty-six cases have been operated upon with a mortality rate of 5.2 per cent. The significance of this contrast is slightly altered by the fact that the percentage of cases with abscess and peritonitis fell from 51.3 per cent in the first series to 41.6 per cent in the second. The average lapse of time between onset of symptoms and operation and the use of purgatives are so far as we can judge from the histories about the same in both series.

Does not the type of incision play a definite rôle in the mortality rate of acute appendicitis? When one studies the tables of the United States Standard Mortality Statistics dealing with appendicitis and the excellent reviews by Bowers it seems apparent that the death rate is lower in those cities where the McBurney incision is most widely used.

The advantages of the McBurney incision are too well known to be discussed. The most important of them appear to be: (1) There is less soiling of the general peritoneal cavity, (2) there is less necessity for handling the intestines for usually it is necessary to touch only the cæcum and appendix, (3) with the modern means of suction the traumatizing effects of gauze packs can be eliminated, (4) drains can be placed in contact with the parietal peritoneum where they soon become in fact, extra abdominal and are not surrounded by intestines, (5) wound complications are less, (6) convalescence is shorter, and (7) the healed wound is less disabling.

Does not chagrin play an unwarranted rôle in the opposition to the McBurney incision? The diagnosis of acute appendicitis may of course be wrong. When it is and has been determined through a McBurney incision it may be the wise procedure to close the wound and let the patient alone as for example in acute salpingitis. Usually the sites of other conditions *simulating acute appendicitis* and requiring immediate operation can be determined through a McBurney incision. An other incision can then be made to suit the condition. Failure to determine the acute trouble through a McBurney incision can always be followed by an exploratory incision with little or no damage resulting from the first incision which frequently can be used advantageously as a drainage point.

The author and the members of our surgical department have long ceased to have feeling of embarrassment after making a McBurney incision for a mistaken diagnosis of *acute appendicitis*. Often as stated no other incision has to be made. Our experience has been that an explanation before operation of the advantages and disadvantages of the McBurney incision and a frank admission of the operator's findings not only may save lives but instead of feeling of chagrin secure for the surgeon the patient's admiration for his honesty.

¹ A complete analysis of this study will soon be published.

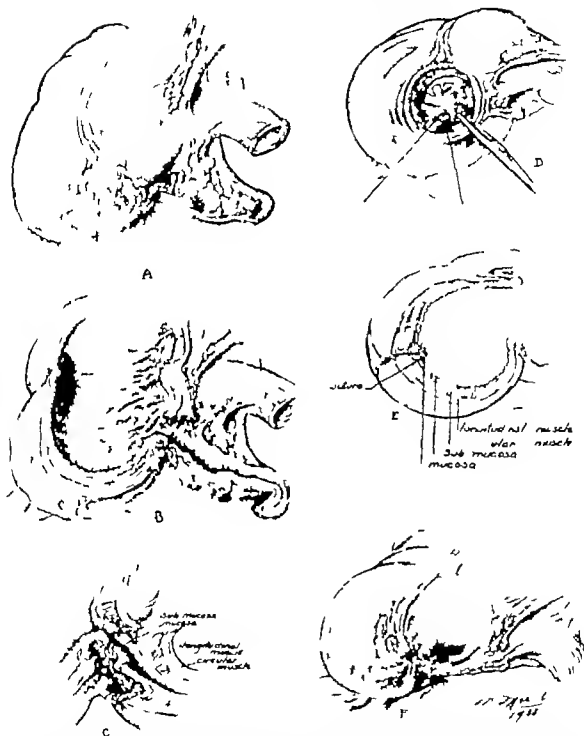


Fig. 1. A, Inflammation, edema, and induration of the cecum associated with gangrene or rupture of the appendix near its base. B and C, Cross sections, showing the effects of a gangrenous process at the base of the appendix. Note the edema and thickening of the muscular coats of the

cecum. D, Thickened muscular coats reflected and a peristomal suture placed in the submucosa above the areas of necrosis. E and F, Stump of submucosa inverted by peristomal suture and the muscular coats rolled back into place without the use of any sutures.

There is more argument against the McBurney incision when the problem is one of differentiating between operating for chronic appendicitis and some other intra abdominal condition. It would be futile to argue this question. I must content myself with a statement of our policy which is either not to operate at all or to remove first the appendix through a McBurney incision and then wait to see if the patient's symptoms disappear. The patient's co-operation in such a program is usually enthusiastic, for he often knows from friends the painful disabling consequences of a long exploratory incision.

What has been written thus far is offered in support of the belief that the surgical technique of appendectomy is playing a more important rôle in the mortality statistics of acute appendicitis in this country than is generally appreciated. Campaigns in favor of immediate operation for acute appendicitis and against the use of purgatives and anodynes are undoubtedly the major avenues toward a reduction of the disgracefully high death rate from appendicitis in the United States. Yet with no appreciable reduction in the elapsed interval between the onset of symptoms and operation or in the use of purgatives or anodynes prior to surgical treatment the death rate for all forms of acute appendicitis (unruptured and ruptured, with abscess and with peritonitis) treated in the Cincinnati General Hospital has been reduced by 50.3 per cent since the routine of a rectus incision was abruptly and completely changed to that of a McBurney incision.

This paper was originally conceived with the idea of drawing attention to two points of technique which we have found especially valuable in the actual removal of certain types of appendices. For them the author claims no originality for he is well aware that they are employed by many surgeons throughout the country. Yet from actual observations and conversations he is convinced that there are many others who do not use them and who might find them as useful as we have.

A. When the appendix is gangrenous or ruptured at or near its attachment to the cæcum and the wall of the cæcum about is thickened, edematous, and often indurated. In such cases

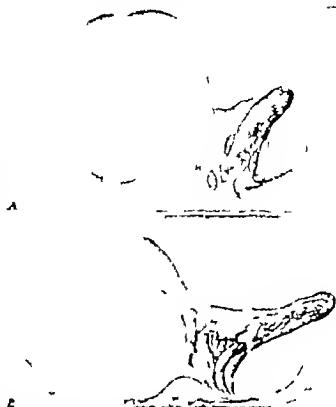


Fig. 2. A Represents the appendix held down by a band of adhesions or a short stalk of peritoneum. B After division of them the appendix is readily delivered and its mesentery easily ligated.

a fecal fistula or a leakage of intestinal contents through the stump is liable to occur for the closure of the hole in the cæcum is at best insecure. Many surgeons realizing the futility of trying to invert the stump of the appendix simply ligate it as best they can and place drains to take care of the leakage which is likely to occur. Others frequently attempt to invert the stump of the appendix and its surrounding gangrenous gut by means of pursestring or mattress sutures. When successful the surgeon is unhappy because of the force with which it is necessary to tie the sutures, and very frequently because of the tension anæmia about them. Not infrequently such sutures cut through the thickened and oedematous musculature of the gut.

For the procedure proposed for and now regularly used in such cases the author finds the basis of his rationale in the fundamental researches of Mall and Halsted who drew attention to the importance of engaging with the sutures the tough fibrous layer of the submucosa whenever repairing defects of the gut wall or performing intestinal anastomoses.

What student of Halsted can fail to remember his demonstration of the ease with which a small straight needle engaging only the musculature of the gut could be torn out and the equal ease with which the needle could be broken without tearing through, if it caught only a small portion of the submucosa?

In the condition under consideration this tough fibrous submucosa does not become swollen and oedematous, and from it the thickened and inflamed muscular layers may be easily separated. When this is done the defect in the cæcum may be easily closed and without tension by placing mattress or purse string sutures only in the submucosa. The reflected and inflamed muscular coats can then be rolled back into place without the necessity of ever taking any sutures through them.

With this method (Fig. 1) of dealing with the stump of the appendix in this particular form of appendicitis, it is necessary to drain fewer cases and the occurrence of fecal fistule has been thus far completely eliminated.

B. When the appendix is not easily delivered into the wound. The difficulty of delivering the appendix may of course be due to many causes such as retrocecal or abnormal positions. Very frequently the tip of the appendix and its base will come up readily into the wound while some part of the intervening portion will be held down close to the posterior peritoneum giving a definite impression that the appendix is badly kinked. The cause of this real or apparent binding of the appendix is most frequently due to a peritoneal stalk which is much shorter than the actual mesentery of the appendix. In many instances there are actual adhesions which may in addition to the short peritoneal stalk, make it difficult to deliver the mesial portion of the appendix. A simple division with a sharp knife of the peritoneum and adhesions along the outer side of the appendix will in most every instance uncover a mesentery which is sufficiently long to allow the entire appendix to be delivered out of the wound before the clamping and dividing of any portion of the mesentery. The operation then becomes easy and one ligature will usually suffice for the ligation of all the vessels in the mesentery. The ease of this procedure is most striking when com-

pared with the difficulty of ligating or clamping the mesentery of the appendix in the depths of the wound, which is not necessary if one first divides the peritoneum and adhesions just lateral to the appendix and carefully frees its mesentery.

Not infrequently when one is pulling on the end of the appendix, the short lateral peritoneum will give the operator the impression that it is a narrow band of adhesions when in reality without traction on the appendix, it becomes smooth flattened normal peritoneum.

With careful sharp dissection, it is most unusual to divide any vessels in either the peritoneum or adhesions which require ligation. Usually in kinked or bound-down appendices the mesentery can be completely freed and the appendix brought through the McBurney incision without the necessity of ligating any vessels (Fig. 2). Then when the mesentery of the appendix is divided the raw surface is easily covered by suturing the peritoneal defect.

SUMMARY

1. In a study of 2035 cases of acute appendicitis operated upon at the Cincinnati General Hospital there has been a decrease of 50.3 per cent in the mortality rate since the operative procedure was changed from a rectus to a McBurney incision.

2. The fear of a mistaken diagnosis of acute appendicitis is probably playing an unwarranted rôle in making surgeons adhere to a rectus or pararectus incision. When the diagnosis is wrong it is our experience that the McBurney incision far more frequently serves a useful purpose than a harmful one. The disabilities and dangers of a long exploratory incision should be borne in mind.

3. A method of dealing with the stump of the appendix in cases of acute appendicitis in which the cæcum is inflamed indurated and thickened is described and illustrated.

4. The importance of freeing the mesentery of the appendix before ligating it is discussed.

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THE RETURN OF SENSATION TO TRANSPLANTED SKIN¹

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THE study of the return of sensation to transplanted skin offers an opportunity to add to our knowledge of the controversial question of sensation. There are several questions, the answers to which might throw some additional light upon a difficult subject. Sensibility of the skin cannot be investigated successfully in the experimental laboratory, but neither can it be investigated clinically by crude and unorthodox methods of sensory stimulation. Although abundant clinical opportunities have presented themselves for the study of the return of cutaneous sensibility in skin grafts and pedicle flap operations, very few have been reported.

Naturally the order and pattern of the return of sensation is the first question which arises. Does the response to pin prick return before that to cotton wool touch and temperature or does sensation to these stimuli return simultaneously? Does the pattern of sensory return advance from the borders of the transplanted skin, does it advance eccentrically or in patches? What are the characteristics of the return of sensation in a skin transplant which has been placed over an area supplied by two peripheral nerves, one of which has been severed? If a skin transplant is placed over an area supplied by two peripheral nerves, and sensation has returned to the transplant, if one nerve is severed will sensation disappear from all of the area supplied by that nerve? Can sensory return be demonstrated in a skin transplant placed over an area the nerve supply of which has been severed, when there has been no return of sensation in the isolated supply of that nerve? Does sensation return as the result of overlap as is the case following peripheral nerve injuries? Do nerve fibers from adjacent uninjured skin grow into protoplasmic hands in the transplanted skin? What effect does the thickness of the transplanted skin have upon the rate of recovery of sensation? Can nerve fibers be shown microscopically in the transplanted skin after sensation has returned?

Quite logically and naturally we immediately become involved in the various theories and fewer facts which have been established regarding sensory recovery following peripheral nerve lesions. From a clinical standpoint our knowledge of the sensory changes which are present during recovery of function in a peripheral nerve is contradictory and in many instances fragmentary.

It has been noted by many observers that the total sensory loss in the skin following complete division of a peripheral nerve is smaller than what we know to be the anatomic distribution of that nerve. This phenomenon has been explained by the supposition that (1) nerve fibers grow into the insensitive area from adjacent uninjured parts, (2) many cutaneous areas receive a sensory supply from different nerves, and (3) that collateral innervation may be easily established by an accessory branch of the injured nerve and an adjacent uninjured nerve.

In 1905 Henry Head (5) had the superficial radial and lateral antehumeral cutaneous nerves of his left arm cut and sutured. In collaboration with Rivers and Sherren he observed the characteristics of the return of sensation in the affected area. As a result of his studies Head came to the conclusion that the skin was supplied by two distinct groups of nerve fibers. One group of fibers transmit protopathic sensibility and are capable of responding to painful cutaneous stimuli and to the extremes of heat and cold. The second group of fibers mediate epicritic sensibility by which is gained the power of cutaneous localization, discrimination of two points and the finer grades of temperature. Head found that heat and cold returned simultaneously with pin prick stimulation but epicritic sensation returned at a definitely later date. Head's theory received general approval but the later more careful work of Trotter and Davies (11), Bonng (2) and Pollock (8) all of whom pointed out the deficiencies of Head's work, remains unrecognized generally. Trot

ter and Davies stated that tactile thermal and pain sensibility appear at the same time at the most proximal part of the affected area and believe that a gradual substitution characterizes the process of regeneration. Boning's conclusions were essentially those of Trotter and Davies except that he believed that the sensation of warmth and cold passes through a stage of hyperesthesia. Pollock emphasized the error of interpreting nerve overlap as evidence of regeneration. He has determined the residual sensibility of the commonly injured peripheral nerves and states that the return of sensibility to prick pain which occurs before the return of sensibility to touch is due to the assumption of function by adjacent nerves. In other words, regeneration can be said to have occurred only when

that portion of the area representing the anatomic sensory supply of an injured nerve which is removed from the influence of overlap becomes sensitive. In this area of isolated supply pain and tactile sensibility return simultaneously.

In an effort to obviate some of the criticisms of nerve overlap Sharpey Schafer (9) made a study of the return of sensation in his own fifth finger and pointed out two facts which have some bearing upon this problem. In the area of sensory loss following crushing of the digital nerve on the ulnar side of his finger pain returned first followed by heat and cold and lastly touch. On the other side of the finger the digital nerve was cut but not resutured. There an unpleasant hyperalgesia occurred and normal touch and temperature sensibility did not return. It should be remembered that crushing produces an indefinite and inaccurate lesion both as to the degree and extent of the lesion.

A most interesting contribution which has a direct relation to this problem has been made by Boeke and Heringa (1). The latter accidentally severed his ulnar artery, several tendons, the dorsal ramus and the superficial and deep branches of the ulnar nerve at the wrist. Tendon and nerve sutures were performed immediately and the wound healed without any signs of infection. Nine months later the affected area showed protopathic sensibility. A piece of skin with the underly-

ing subcutaneous tissue was removed from the center of this area and examined for nerve fibers and their endings. Microscopic examination showed that the nerve in both the superficial and deeper layers of the skin showed protoplasmic bands filled with neurofibrillae. Myelin sheaths were not found but regeneration was noted in the end organs of Ruffini in some of Meissner's tactile corpuscles and in the nerves supplying the hairs. Consequently these investigators concluded that protopathic sensibility was due to stimulation of incompletely regenerated sensory organs and that only when this regeneration was complete did epicritic sensibility appear. It will be noted later when the records of the examinations of the clinical material are given that they lend support to this conception of sensory regeneration.

Although there have been many opportunities for the clinical examination of the recovery of sensation in skin transplants the reports in the literature have been scanty. In 1899 Stranek (10) reported the early return of light touch sensibility in a full thickness skin graft but after 10 days the entire graft melted away. Stranek's results on the whole are of little value since they were based upon an insufficient amount of evidence. Du Breuilh and Noel (4) examined 11 cases of Wolfe grafts and found that superficial sensibility returned within a year. Williams (12) examined a Thiersch graft which had been applied over the base of a varicose ulcer 30 years previously. He found that pain, temperature, and deep pressure sensibility were slightly diminished but there was a greater loss of tactile sensation. J. S. Davis and Traut (3) have stated that sensation begins at the periphery in all types of skin grafts within 4 or 5 weeks and that tactile sensation is restored first followed by pain and temperature sensation. Kredel and Evans (7) in a recent and by far the most complete report, concluded that in pedicle flaps, pain, touch and temperature sensibility return independently and in that order that in pedicle flaps sensation begins about the periphery and progresses distally and from the sides that there is no relation between the course of the original neurilemmal sheaths of a skin flap and the ingrowth of new nerve

fibers, and finally that recovery of sensation is more rapid and complete in pedicle than in Wolfe, Reverdin, or Thiersch grafts

Finally, some aid may be found in the experimental work which has been reported upon the regeneration of sensory nerve endings. Kadanoff (6) transplanted skin from the sole to the snout in guinea pigs. He found that the new nerve fibers, more numerous than was normal for the foot frequently followed the old paths, or the blood vessels. He never found regenerating Pacinian corpuscles nor on the other hand did he ever find degenerative changes in the sensory endings immediately after transplantation

CLINICAL MATERIAL¹

Our examinations have been made upon a group of pedicle, free full thickness, and Thiersch skin grafts and have been carried on over the period of years from 1920 to the present time. The majority of the pedicle flaps were transferred from the thighs but tocks, and abdomen to repair deforming defects in the hands produced by neglected and ill treated infections, and burns. The transplants were made by delayed transfers to insure an adequate vascular supply. Consequently all of the original nerve supply had been divided completely. A few of the early pedicle and full thickness grafts included more of the subcutaneous tissue than is now the accepted practice

Methods of examination Pin prick stimulation was effected by a simple algometer which consisted of a large beaded pin in the barrel of a glass syringe the point being allowed to extend through the tip and to replace the plunger. The weight of the plunger determines the degree of pressure when the pin is allowed to prick the skin with the syringe held by the barrel. By so using a stimulus of known degree, the area of sensory loss may be compared accurately from time to time

Tactile sensibility was tested for by a wisp of cotton after all of the hairs on the skin had been shaved. Two point discrimination sense was not used uniformly in all of the examinations

Test tubes containing warm and cold water are relatively inaccurate for testing temperature sensibility and are subject to the danger of stimulating pressure sense. Low degrees of temperature only were tested and for this purpose a pledget of cotton twisted to a point and moistened in ether was used as the stimulus

In the accompanying charts of sensory recovery the black dots represent return of pin prick sensation, black lines return of touch, x, painful response to pinprick stimuli, circles return of cold sensation, s, diminished sensation, solid black, loss of all types of sensation

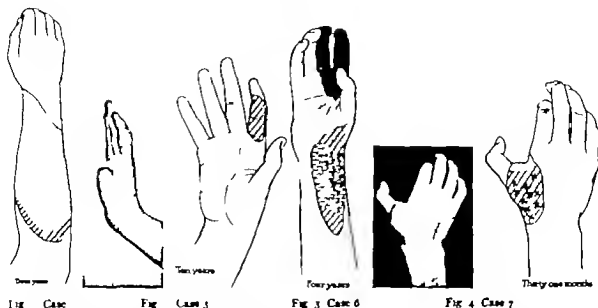
CASE 1 J G In 1917 a large pedicle transplant (13 by 8 centimeters) was transferred from the abdomen to the dorsolateral surface of the forearm to cover a defect produced by an osteomyelitis of the bones of the forearm. The median and ulnar nerves were intact but the superficial ramus of the radial had been destroyed. In 1920 there was a loss of pain sensation in the center of the transplant and the loss of tactile sensation was larger. The return of sensibility was evidently progressing from the edges. The patient was not examined again until 1923. Pin prick was felt everywhere over the flap and almost in the center there was an area of protopathic response. Here touch was not recognized (Fig 2).

CASE 2 W McG This patient had received a gunshot wound of the left hand in 1917. In July of 1920 a pedicle flap was transferred from the abdomen to the dorsum of the hand. The median nerve had been divided by the injury and was sutured in October of 1920. There was loss of pin prick and touch sensibility limited to the volar and dorsal surfaces of the index finger and to a small area over the dorsal surface of the hand. The sensory overlap in this case had therefore been very extensive. The transplant measured 8 by 5 centimeters. The patient left the city and was not examined until January of 1929. There was a loss of tactile sensation in a small area at the distal border of the transplant but elsewhere sensation was normal. The volar and dorsal surfaces of the index finger showed a protopathic response to pin prick but no return of tactile sensation.

CASE 3 C N When one year old this patient's right index finger was burned severely by an electric bulb. A pedicle transplant was transferred from the buttocks in April of 1921. Ten years later the transplant showed normal sensation to all stimuli (Fig 2).

CASE 4 W R. When 2 years of age the patient fell into a grate fire and severely burned his right hand. Six years later (1921) the scar tissue was dissected from the palm of the very badly deformed hand. A pedicle transplant was transferred from the buttocks to cover the palmar defect. On February 8, 1923 the patient recognized pin prick over the entire transplant. The response was very definitely protopathic in character and was accompanied by a

¹These studies were made upon the patients of Drs. Kavanet, Koch, and Mason at Pottsville Memorial and Wesley Memorial Hospitals



withdrawal reflex. Touch was not recognized. On January 10, 1927, this protopathic response to pin prick stimuli had disappeared completely. Tactile and cold stimuli were recognized everywhere over the transplant.

CASE 5 A. N. When 6 months of age this patient suffered a severe burn on the dorsum of the right hand. A marked deforming contracture resulted. The scar tissue was dissected away and a pedicle transplant was transferred from the abdomen. Six years later (1928) the transplant had grown in proportion to the rest of the hand. Sensation to pin prick and touch was present over the entire flap but the response to pin prick was definitely hyperalgesic.

CASE 6 J. C. The patient received a gunshot injury of the right forearm in 1922. The median nerve was destroyed for a distance of 3 inches above the

wrist so that an end-to-end suture was impossible. A pedicle transplant was transferred from the thigh in October of 1923. In January of 1927 there was a small area of normal sensation to pin prick and tactile stimulation in the proximal portion of the transplant. On the radial side of the flap there was protopathic response to pin prick and tactile sensibility was greatly diminished. On the ulnar side of the transplant pin prick and tactile sensibility were present but diminished (Fig. 3).

CASE 7 W. M. The patient received a gunshot wound through the palm of the hand in January of 1924. There was a large loss of tissue on the dorsum of the hand between the metacarpal of the thumb and index finger. A pedicle transplant was transferred to this area from the abdomen on July 1, 1924. At this time there was a loss of pin prick, touch, and temperature stimulation over the entire volar surfaces of the index and middle fingers and on the dorsal surfaces of the distal two phalanges. On September 30, 1924, there was no return of any type of sensation over the transplant. On February 6, 1927, there was a protopathic response to pin prick stimulation over the flap except for a small area distally where pin prick was not felt. Tactile stimuli were recognized but less acutely than normal. Cold sensibility was recognized everywhere over the transplant (Fig. 4).

CASE 8 L. K. The wrist and palm of the right hand were lacerated severely in an automobile accident. Infection and deforming scar contractures resulted. In September, 1924, a pedicle transplant was transferred from the lumbar area to the hand. On January 23, 1925, there was a definite protopathic response to pin prick over this entire flap, except over a areas which were the most distal. Tactile sensation could be recognized only about the periph-



Fig. 5 Case 8.

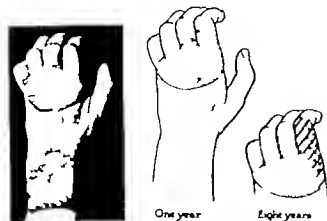


Fig 6 Case 12

ery of the transplant. Cold sensation was recognized in scattered areas. On March 25 1925 the response to pin prick stimuli had become more painful. Tactile stimuli were recognized over the entire transplant but in scattered areas. The orderly progress of the latter sensation from the periphery had ceased (Fig 5).

CASE 9 S D. The palmar surfaces of all of the fingers were severely burned and flexor contractures were the result. Pedicle transplants were transferred from the lumbar region in July of 1925. The patient was not examined until May 31 1927 when pin prick, tactile and cold sensibility were all recognized.

CASE 10 G C. This boy received a severe rope burn of the left hand which resulted in contractures and partial amputations. A pedicle flap was transferred from the lumbar region to the fingers in July of 1925. There were no lesions of the peripheral nerve trunks. On February 3 1927 the transplanted skin was sensitive to pin prick, touch and cold stimuli. There was no typical protopathic response but there was a definite hyperalgesia and hyperesthesia.

CASE 11 O N. This patient's flexor tendons, median and ulnar nerves were divided at the wrist in an automobile accident. The wound became infected and there was a considerable loss of tissue. A pedicle transplant was transferred from the lumbar region to the wrist in February of 1926. An examination in March of 1927 showed a complete return of sensation to pin prick and tactile stimuli. There was no recovery of sensation in the hand in the areas supplied by the median and ulnar nerves.

CASE 12 J O. This patient received a severe injury to the left hand. The ulnar nerve and flexor tendons were cut and there was a loss of tissue over the dorsum of the hand. A pedicle transplant was transferred from the abdomen February 23 1926. On February 6 1927 pin prick was recognized, accompanied by a very marked protopathic response and withdrawal over the radial half of the transplant. Tactile sensation was absent. Neither pin prick nor tactile stimuli were recognized over the ulnar side of the transplant although pressure stimuli were recognized. On February 5, 1934 tactile and

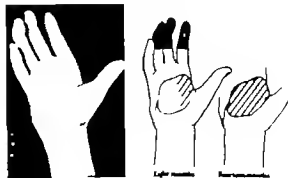


Fig 7 Case 14

cold stimuli were recognized over the radial side of the transplant. Pin prick was felt except over the ulnar side of the flap (Fig 6).

CASE 13 F G. Scar tissue resulting from a burn was removed from the web between the right thumb and index finger. A pedicle transplant was transferred from the abdomen on April 6 1926. On April 11 1927 sensation to pin prick touch temperature and two point discrimination was present over the entire flap. There was some slight hyperalgesia and hyperesthesia at the edges of the transplant.

CASE 14 H W. In November of 1925 the patient received a shot gun charge in the palm of the right hand. A pedicle transplant was transferred to the hand from the lumbar area in May 1926. In November of 1926 a neurolysis of the branches of the ulnar and median nerves in the palm was done. January 28 1927 there was partial return of pin prick and tactile sensibility over the transplant. The distal portion of the palm of the hand the volar surfaces of the proximal phalanges of the index middle and ring fingers, and the entire little finger showed a normal response to pin prick but tactile sensation was absent. The distal two phalanges of the index middle and ring fingers were analgesic and anesthetic and ulcers were present on the tips of the middle and ring fingers. Sensation over the thumb was normal. July 29 1927 sensation over the transplant was normal. Pin prick was felt over the fingers but tactile sensibility was still imperfect (Fig 7).

CASE 15 E McF. Scar tissue following a severe burn of the right hand was removed and a pedicle transplant from the abdomen was transferred to the palm and volar surfaces of the ring and little fingers. On February 5 1927 there was complete sensory recovery to pin prick cold and tactile stimuli over the entire transplant. A slight protopathic response to pin prick was still present.

CASE 16 B B. The patient received a crushing injury of the dorsum of the right hand and a pedicle flap was transferred from the abdomen in 1926. The patient was not seen again until January 5 1934. Pin prick, heat, cold and tactile stimuli were recognized over the entire transplant. Sensation to touch was diminished as compared to the normal skin.

CASE 17 S H. The patient had a deforming scar contracture of the right hand resulting from a burn

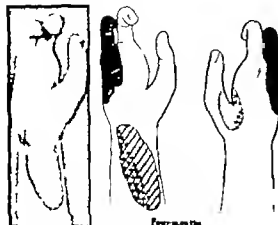


Fig. 8. Case 19.

suffered 22 years previously. A pedicle transplant was transferred from the lumbar region to the hand on July 5, 1926. On January 28, 1927, the patient recognized pin prick stimuli over the entire flap. A painful sensation radiated from each stimulus. Three months after the transplant was transferred, the patient a doctor recognized pin prick. Cold stimuli were not recognized and tactile sensation was present but diminished.

CASE 18. B. G. This patient had a pedicle transplant transferred from the lumbar area to cover a defect in the palm which resulted from the dissection of a severe burn scar contracture in July of 1926. On February 27, 1927, sensation to pin prick, touch and temperature stimuli was normal over the entire transplant. A protopathic response was not present. There was a slight loss of touch and pin prick along the radial side of the ring finger, probably the result of an injury to the digital nerve.

CASE 19. G. S. A high voltage electric burn was followed by a lesion of the ulnar nerve and a deforming contracture of the right hand. Pedicle flaps from the lumbar area were transferred to the hand between the thumb and second metacarpal and to the volar surface of the forearm on November 1, 1926. Sensation in the hand was lost over the ulnar distribution. The nerve was sutured. On March 3, 1927, there had been no sensory recovery in the hand. Pin prick was recognized over the entire forearm transplant and a withdrawal reflex occurred with each stimulus over the ulnar side. Cotton wool was appreciated more acutely over the ulnar half of the flap than elsewhere. Cold stimuli were appreciated. A protopathic response to pin prick occurred only over the ulnar half of the transplant between the thumb and index finger. Tactile and cold stimuli were not recognized over this transplant (Fig. 8).

CASE 20. E. R. On March 3, 1929, the right hand was severely injured in a laundry mangle. Scar tissue involved the dorsum of the hand and fingers as far as the first interphalangeal joints. There was almost complete loss of motion of all four fingers. On

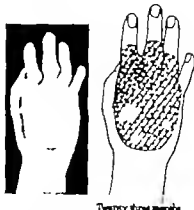


Fig. 9. Case 20.

November 6, 1929, a pocket flap from the right thigh had been transferred completely to the dorsum of the hand. Later arthroplasties and tendon transplantations were performed so that examination of sensation could not be done accurately until October 26, 1931. Pin prick, touch and cold stimuli were felt over entire flap except for a small area near radial border. Here pin prick was recognized less accurately and cold and tactile sensation were lost (Fig. 9).

CASE 21. B. McIL. On July 17, 1930, the patient fractured three fingers and received a severe laceration of the dorsum of the left hand. On December 17, 1930, a pedicle transplant had been transferred completely from the thigh. November 25, 1931, pin prick and cold stimuli were recognized over the entire transplant. There was a loss of tactile sensation in the web between the index and middle fingers.

CASE 22. G. A. The patient received a gunshot injury of the left forearm which divided the ulnar and median nerves just proximal to the wrist and all of the superficial flexor tendons. An abdominal pedicle flap was transferred on March 27, 1931. On October 19, 1931, a protopathic response to pin prick stimuli and tactile sensibility was present over a small area on the ulnar side of the transplant. On February 1, 1932, there had been no recovery of sensation in the median and ulnar distribution over the palm or fingers. Pin prick was recognized over the transplant but at its distal edge the stimulus was accompanied by a protopathic response. Tactile stimuli were appreciated only at the proximal edge of the transplant and each stimulus evoked a protopathic response similar to that produced by pin prick. Cold stimuli were recognized everywhere without an unpleasant spread of the sensation (Fig. 10).

CASE 23. A. K. On July 30, 1930, the left hand was crushed and burned in a laundry mangle. On August 28, 1931, a thin translucent pedicle flap was transferred from the thigh to the dorsum of the hand. In some areas it had been necessary to scrape the scar tissue from the bone. On October 19, 1931, there was a complete sensory loss to pin prick, cotton wool and cold stimuli over the entire flap except for



Fig. 10 Case 22.

a slight recognition of pin prick at the distal end of the transplant over the index finger. On February 1 1934 there had been a complete return of pin prick touch, and cold sensation over the entire flap. There was no protopathic response.

CASE 24 J. G. A pedicle transplant was transferred to the dorsum of the right hand between the thumb and index finger on October 13 1930. On November 31 1931 sensation to pin prick touch and cold stimuli was normal over this area of skin. In June 1930 a similar transplant was made to the ulnar border of the right hand. Twenty months later sensation to pin prick touch and cold stimuli was normal over that transplant. On October 25 1931 a pedicle transplant was transferred to the palmar surface of the thumb. On November 21 1931 there was a small area of sensory return to pin prick over the distal surface of the transplant.

A pedicle transplant was transferred to the palm of the left hand in March of 1931. On November 21 1931 pin prick sensation had advanced from the periphery to a small oval area of loss in the center of the transplant. Tactile and cold sensibility was absent over the entire flap. A small area of the transplant at its proximal border was removed for microscopic study of nerve endings November 21 1931.

CASE 25 V. S. On June 9 1932 the patient received a severe denuding injury of the dorsum of the left hand and fingers. Denudation was complete except for a small area of skin over the dorsolateral surface of the hypothenar eminence. The ring finger was amputated traumatically and the rest were removed later leaving only the thumb and little finger. On July 29 1932 a pedicle abdominal flap had been transferred completely to the dorsum and palmar surfaces. Areas of the latter portion of the transplant melted away and were replaced by free

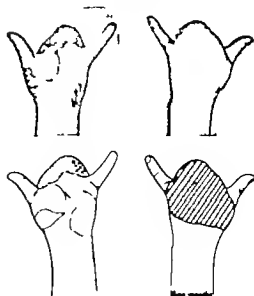


Fig. 11 Case 25

full thickness and Thiersch grafts in October of 1932.

On April 12 1933 pin prick and tactile stimuli were recognized over the dorsal transplant. The patient was hypersensitive to tactile stimuli. Pin prick but not touch was recognized over the free full thickness transplant. There was a small area of hyperalgesia over this graft. Neither pin prick nor tactile stimuli were recognized over the Thiersch graft (Fig. 11).

CASE 26 W. F. C. An X-ray burn of the left hand was followed by an ulcer on the dorsum of the left index and ring fingers and amputation of the middle finger. A pedicle transplant from the abdomen was transferred to the index finger on November 7 1933 and to the ring finger on January 15 1933. On May 17 1933 pin prick cold, and tactile sensations were present over the index finger transplant except over its most distal portion. There the loss of pin prick was less than that of touch. There has been no return of tactile or pin prick sensation over the ring finger (Fig. 12).

CASE 27 R. G. The patient received an electric wire burn of the right forearm and in November of

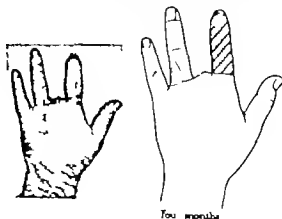


Fig. 12 Case 26



Fig. 1 Case 1



Fig. 3



Fig. 14 Case 25



1932 a large pedicle transplant was transferred from the abdomen. The median nerve had been divided and was sutured. On November 22 1933 pin prick and touch stimuli were recognized over the ulnar side of the dorsal surface of the flap. The entire volar surface of the transplant was analgesic and anesthetic except for a small area on the radial side at its proximal extremity. The return of pin prick sensibility was greater than that of touch and no protopathic response was present (Fig. 15).

CASE 28 I. McC. The patient received a laceration of the dorsum of the hand in an automobile accident September 21 1932. An abdominal pedicle flap was transferred on March 31 1933. Upon examination May 24 1933 there was no response to any type of sensory stimulus. On October 30 1933 pin prick and cold sensibility was present over the proximal portion of the transplant. Tactile stimuli were recognized in this same area but this was below normal. Only pressure sensation was present in the distal half of the transplant.

On February 1 1934 sensation to pin prick and touch had advanced distally and as before the latter was less in extent than pin prick. Cold stimuli were recognized in the area of return to pin prick. There was no protopathic response from any type of stimulation (Fig. 14).

CASE 29 F. M. In an automobile accident August 10 1931 the patient received a compound fracture of the right humerus and of both bones of the right forearm. The median nerve was divided. A gas bacillus and streptococcal infection developed. On June 23 1933 the median nerve was sutured and in August of 1933 an abdominal pedicle flap was transferred completely to the forearm. On November 24 1933 pin prick and tactile sensation was present over the radial half of the volar surface of the transplant. The dorsal surface of the transplant was

insensitive except for a small area on the radial side where pin prick and touch were recognized. Loss of all sensations was present over the volar surface of the index finger. Sensation over the rest of the palm of the hand and fingers was normal.

On January 1 1934 there had been no advance in the area in which pin prick and touch were recognized on the volar surface of the forearm. However, both stimuli elicited a very painful spreading "electric shock" sensation which had not been present before. On the dorsum of the forearm pin prick had advanced from the radial side to the scar joining the edges of the transplant. There was no protopathic response. Touch was recognized in this same area. On the ulnar side of the dorsum of the forearm pin prick was recognized at the distal edge of the graft and was accompanied by a marked protopathic response (Fig. 15).

CASE 30 J. P. A pedicle transplant from the abdomen was transferred to the volar surface of the right forearm to cover a traumatic defect on October 21 1933. The median nerve was injured and sensation was lost over the palmar surface of the index finger. Elsewhere in the hand sensation was normal. On November 21 1933 there had been no recovery to pin prick, cold or tactile stimulation over the transplant although pressure was recognized easily. A split graft from the thigh was used to cover the abdominal defect. On the same date of examination there had been no recovery of sensation.

CASE 31 A. B. In June, 1928, a free full thickness graft was taken from the thigh to cover a defect in skin on the volar surface of the left elbow. The median ulnar and radial nerves were uninjured. On November 21 1933 there had been no return of sensation to pin prick, touch, or cold stimuli at any point over the transplant.

CASE 32 E. B. A free full thickness transplant was transferred from the thigh to the palm of the right hand in August 1931. The patient had suffered a severe burn from X-ray treatment for dermatitis. On November 24 1933 pin prick and tactile stimuli were recognized over the entire flap. There

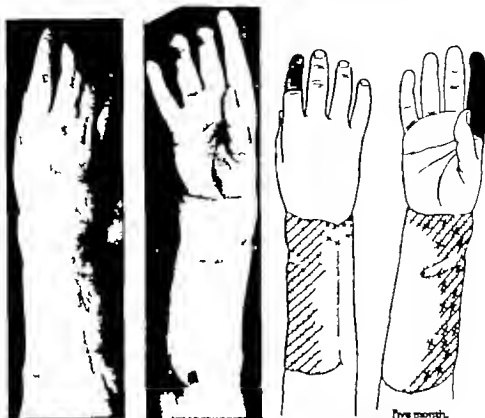


Fig. 15. Case 29.

was no protopathic response but the sensation was not as acute as over the skin on dorsum of hand.

CASE 33 F. M. This patient's hand was injured in a laundry mangle. In March of 1932 a free full thickness transplant was placed in the palm and on the volar surfaces of the index, middle, ring and little fingers after dense scar tissue had been removed. Part of the transplant to the index finger melted away and in July of 1932 a pedicle transplant was transferred to the tip of that finger. In October 1933 sensation to pin prick, touch, and cold stimuli was normal over the free full thickness transplants except for a small area at the proximal edge of the graft at the base of the ring finger. In this area none of these stimuli was recognized. There was a small area in the center of the small pedicle flap where pin prick and touch sensation were diminished. On the edges of that transplant there was a protopathic response to pin prick stimuli (Fig. 16).

CASE 34. W. R. Contractures of the ring and little fingers of the right hand resulted from a burn. A free full thickness graft was taken from the thigh in December of 1926 to cover the defect which followed removal of the scar tissue. On April 25, 1927, pin prick and tactile sensation were present over transplant but were diminished slightly over fifth finger.

CASE 35 S. R. The left hand was caught in a pulley and a scar contracture of the fourth and fifth fingers developed. A free full thickness transplant was transferred from the abdomen in June of 1926. On March 31, 1927 tactile and pin prick stimuli were recognized over the entire graft.

CASE 36 F. B. A rope burn resulted in a severe contracture of the fingers of the left hand. A free full thickness transplant was transferred from the abdomen to the flexor surfaces of the index, middle, ring and little fingers in January 1927. On examination in March of 1928 tactile and pin prick stimuli were recognized over the entire flap. There was no evidence of a protopathic response.

CASE 37 D. R. The patient was treated for pruritus and by X rays and received a severe burn of the right buttocks. When the involved skin had been removed a Thiersch graft was placed over the defect in March of 1932. The area grafted measured about

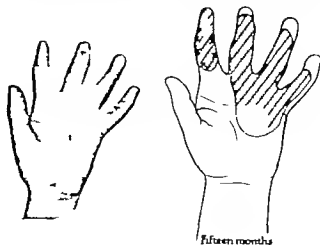


Fig. 16. Case 33.



Fig. 6

12 by 5 centimeter. On November 17, 1933, the patient recognized pressure stimuli over the entire graft but pin prick, touch, and cold stimuli were present only in a small area near the upper margin of the transplant.

CASE 18. A. F. In June of 1931 a free full thickness graft was placed on the dorsum of the right hand to cover a defect in skin which followed an automobile accident. On December 25, 1933, although pin prick and tactile stimuli were recognized over the transplant there was a definite hyperesthesia and hypalgesia.

CASE 30. W. T. The patient had an X-ray ulcer of the back which was removed by a wide dissection. A Thiersch graft to this area was not successful. A skin flap was moved up to cover the defect and a Thiersch graft was used to cover the area from which the flap had been shifted. The Thiersch graft was applied in August, 1933. On November 23, 1933, pressure, touch, and cold stimuli were recognized but tactile sensation was absent. Pin prick stimuli were recognized in two small areas and there was no protopathic response (Fig. 17).

DISCUSSION

Several generalizations may be made about the return of sensation in transplanted skin. In this material the return of sensibility has been more complete in the pedicle transplants. Sensation has recovered more rapidly in those pedicle transplants which have had only a small amount of subcutaneous tissue attached to the skin. The return of sensation to Thiersch and free full thickness grafts has not been as complete as one might expect al-



Fig. 7

though several of these types of transplants were made to areas injured by X-ray exposures. It is possible that nerve endings and fibers had been destroyed permanently by that agent.

Kredel and Evans (7) emphasized the question of the polarity of the pedicle flaps and its effect upon the return of sensation. Although this was not studied throughout the 14 years of observing and examining these patients, a review of the operative notes and sketches brings a conclusion in agreement with them. Changing the polarity of the transplant does not affect the time or character of the return of sensation.

In every instance there was a dissociation between the recovery of pin prick, touch, and temperature sensation. Pin prick sensibility always recovered first and the area of return of tactile sensibility was therefore within that of pin prick. In every case when examinations were made at frequent intervals after operation a hyperalgesia was present which resembled Head's protopathic pain. The painful sensation spread like an electric shock from the point of stimulation and the point of the stimulus could not be localized. This reaction began to disappear as tactile stimuli were first recognized. As touch sensibility became more definite and advanced the protopathic response with reflex withdrawal disappeared entirely. Cold stimuli were recognized in the area occupied by the recovery of pin prick sensibility. In a very uniform manner in the pedicle flaps sensation advanced from the edges of the transplanted skin to the center and the progression advanced more distally than in a perfect circular fashion. In Thiersch

and free full thickness transplants return of sensibility in patches was more common

It is difficult to believe that old sheath cells play an important rôle in regeneration and the recovery of sensation. It is more likely that the severed ends of nerve fibers in the normal skin and subcutaneous tissue to which the transplant becomes attached send processes into the graft which in the beginning are devoid of myelin sheaths. In an effort to study the type of nerve fibers in transplanted skin to which sensation had returned specimens of skin were removed from three pedicle grafts and one Thiersch graft. In one instance the pedicle transplant had been in place 3 years another 1 month and the third, 3 months. The Thiersch graft had been applied 34 days previously and had shown no evidence of return of sensation. In each of the pedicle transplants there had been a return of pin prick sensation and in one tactile stimuli were appreciated. The specimens were divided into smaller blocks and in one, serial sections were mounted. They were stained by the Bielschowsky technique. In one half of the sections a counterstain was made with hæmatoxylin.¹ Nerve fibers were not found in any of the specimens, neither medullated nor non medullated. Had the axons failed to impregnate the hæmatoxylin counterstain would have made it possible to detect with ease any medullated nerves had they been present.

Observations upon a transplant placed over the volar surface of the index finger with the median nerve severed at the wrist for example, have not been made. Neither are there examples of transplants over other isolated areas of nerve supply. The examination of such a transplant will afford valuable evidence of sensory return. The nearest approach to this situation was in Case 12 in which the ulnar nerve was cut. After 8 years sensation to pin prick had progressed slowly ulnarward but even at that time the little finger portion of the transplant was analgesic. There are other questions which cannot be answered as

yet because just the correct combination of clinical conditions have not been present.

The fact that pin prick stimuli are recognized first and that when tactile stimuli elicit a response the extremely painful character of the pin prick disappears may be observed repeatedly. These facts are in agreement with those of Boeke and Hennig. They also are evidence that this type of sensory return is due to nerve overlap as Pollock has claimed in recovering peripheral nerve lesions. He has stated that recovery of sensation in the isolated supply occurs simultaneously for all types. In our experience touch sensation has never returned first. It should be emphasized again that tactile sense and pressure sense are two different things the latter involves the muscles tendons and bones. We cannot find sufficient evidence to state that simply because the return of sensation is dissociated this alone is direct evidence of the existence of separate fiber pathways in the peripheral nerves for each type of sensation.

It has been noted that sensation has begun to recover as early as 4 to 5 weeks. In some cases it has not recovered completely after many years. The rate and extent of recovery depend upon the type of the transplant its thickness the presence of scar tissue and the state of the adjacent peripheral nerves which have cutaneous branches in the area involved.

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¹Dr. H. J. Wilkinson, Professor of Anatomy at the University of Adelaide, very kindly made these microscopic studies. Professor Wilkinson has had a large experience in the use of this staining method which he perfected. He said, "If any non-medullated nerves exist in the blocks examined, my staining method failed to reveal them. Thus, of course, is possible. If the technique has failed, however, it is the first time since I returned, and I can only suggest that the common method in use for the formal fixation of tissues is at fault."

EARLY AMERICAN MEDICAL SCHOOLS

NORTHWESTERN UNIVERSITY MEDICAL SCHOOL

J ROSCOE MILLER, M.S. M.D. CHICAGO

NORTHWESTERN University Medical School has the distinction of being the first to introduce a graded curriculum into medical education in the United States. In fact, the keen desire of its founders to introduce this innovation was responsible for the founding of the school.

In the early part of the nineteenth century there were only four medical schools in the United States. These offered two courses of instruction of approximately sixteen weeks each and granted a diploma (Doctor of Medicine) the possession of which was sufficient to allow the owner to practice medicine. The number of graduates from these four schools was small. The laws of

medical schools were besieged by anxious applicants for entrance. The result was the establishment throughout the country of numerous medical colleges. As these were run solely on the funds collected from the students and as the latter desired the degree of Doctor of Medicine more than the training, the standards set were negligible. By 1850 there were thirty-six medical schools turning out thirteen hundred graduates each year. No preliminary education was required and attendance at lectures was dependent entirely on the student's wishes. The school 'year' consisted of twelve to sixteen weeks during which courses of lectures were given. These were not arranged in any logical sequence and the second 'year' consisted of a repetition of the first.

In 1844 Nathan S. Davis, a young delegate from the Broome County Medical Society, suggested to the New York State Medical Society at its annual meeting that some plan be formulated whereby medical and premedical education could be systematized and standards established. The persistent work of Dr. Davis resulted in the founding of the American Medical Association. In May, 1847 the prime object of this organization being the elevation and standardization of medical education in the United States.

In 1849 Dr. Nathan S. Davis was offered a position on the faculty of Rush Medical College (Chicago) which he accepted. He thereupon changed his address but not his views



Nathan Smith Davis

many states allowed apprenticeship in a practicing physician's office for a period of three or four years to be substituted for the two year medical course. After this period of training had been served, an examination was given by the censors of an organized medical society and if successfully passed, the candidate was licensed to practice. Attendance at one of the established medical schools, however, deducted one year from the period required in a practitioner's office and it soon became well known that it required less time and money for a young man to apprentice himself for a period of three years, at the same time being registered in a medical school than to serve four years and then be required to take the examination. As a consequence the existing

on medical education. At Rush he met a number of men who shared his opinions but the majority of the faculty and trustees were not in agreement and in 1859 a small group left Rush Medical College to establish the medical department of Lind University an institution named for Sylvester Lind, a Chicago business man. Lind University had recently received a liberal charter from the State.

The six men who undertook the task of organizing a new medical school along the lines they had so long advocated were Drs. Hosmer A. Johnson, Edmund Andrews, Ralph N. Isham, David Rutter, Nathan S. Davis, and William H. Byford. The curriculum which they inaugurated consisted of two consecutive college years of five months each, so arranged that dissection and laboratory work were taken the first year and hospital clinical instruction the second year. A third year, largely clinical in character was recommended and urged but not required for graduation.

The school was located in the five-story brick "Lind Block" at Randolph and Market Streets, and the first term began October 9, 1859. The enrollment was thirty three, fourteen of the students being seniors who had completed at least one year in another medical school. The faculty of this pioneer school was constituted as follows: David Rutter, M.D., eminent professor of obstetrics; Hosmer A. Johnson, M.D., professor of materia medica and therapeutics; Edmund Andrews, M.D., professor of principles and practice of surgery; Ralph N. Isham, M.D., professor of surgical anatomy; Nathan S. Davis, M.D., professor of principles and practice of medicine; William H. Byford, M.D., professor of obstetrics and diseases of women; John H. Hollister, M.D., professor of physiology and histology; F. Mahla, M.D., professor of chemistry and toxicology; M. R. Taylor, M.D., professor of general pathology; Titus Deville, M.D., professor of descriptive anatomy; Henry G. Spofford, Esq., professor of medical jurisprudence; and Horace Warner, M.D., demonstrator of anatomy.

The first year was a success and nine members of the senior class were graduated March 5, 1860. During the second year there were fifty-one students and in the third year sixty-three.

The outbreak of the Civil War brought about drastic changes in the medical school as many members of the faculty resigned to serve in the Army. The school work continued however and the number of matriculants increased to seventy-nine in the fourth year. The five-month college term had been augmented by four months of



Lind Block. The Medical department of Lind University occupied the third and fourth floors of this building from 1859 to 1863.

clinical instruction during the summer. Due to the Civil War Sylvester Lind was in financial difficulties and was unable to fulfill his pledge of \$100,000 to the University. The medical faculty was thereby released from its original terms of agreement, and at the opening of the regular college term in 1863 it was decided to continue the school as an independent unit under the name of the Chicago Medical College. A new building was erected at 22nd and State Streets. The *University Bulletin* of this period credits the medical school library with the possession of one thousand bound volumes and the leading medical periodicals of the time. Clinical teaching was carried on at Mercy Hospital which had been organized by Dr. N. S. Davis, Judge T. Lyle Dickey, Judge Mark Skinner, Captain R. K. Swift, and Dr. John Evans. It had its beginning in 1850 as "The Lake House," where the nursing was done by medical students. It was taken over by the Sisters of Mercy and named Mercy Hospital in 1851. From this period until 1919 Mercy Hospital was used for much of the clinical teaching done by Northwestern University Medical School.

In 1869 the Chicago Medical College became the medical department of Northwestern University but the affiliation was a loose one. The University granted the degree of Doctor of Medicine to those students recommended by the faculty. Undergraduates in the school of liberal arts were allowed to study chemistry in the medical school. The latter retained title to its property and managed its own finances. At this time Northwestern University advanced \$45,000.00 to the medical school for a new building



The Chicago Medical College 1870-1893

and 1891. Each year to apply on the salary of the professor of chemistry. For the following year this affiliation continued unchanged. The medical department was still the only one in the United States with a graded curriculum.

In 1875, having again outgrown its quarters, the medical school was moved to a new building adjoining Mayo Hospital at 26th and Prairie Avenue, and the association between the two institutions became closer; the professors of clinical subjects teaching at the hospital.

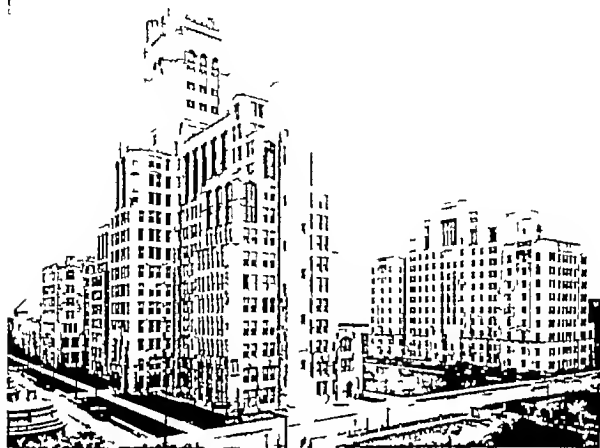
In 1890 all property of the medical school was given in trust to the University and the name changed to Northwestern University Medical School. The entrance requirements were made equivalent to one year in high school and a four-year course of medical study was a prerequisite to obtaining the doctor's degree. At the same time the college year was increased from five to seven months. In 1897 the requirements became the same as those necessary to enter the school of Arts and Sciences.

In 1890 William Deering, long a staunch friend of the medical school, aided in the purchase of a tract of land at 25th and Dearborn streets. Here a building was erected for the schools of medicine, dentistry and pharmacy. Adjoining this building a small two-story brick structure was built to house Wesley Hospital. In 1901 a new hospital

building was constructed on the same site and additions made in 1910. From its founding to the present date Wesley Hospital has maintained a close affiliation with the medical school and much of its clinical teaching has been done there.

The medical building erected on south Dearborn Street and occupied in 1893 was at the time one of the best medical plants in the country. Gradually the space occupied by the departments of dentistry and pharmacy was needed by the medical school and by 1901 the medical school occupied the entire building. In 1894 William Deering augmented his previous gifts by \$50,000.00 to be used as an endowment for the chair of physiology. This was named for Dean N. S. Davis. Later the chair of anatomy was endowed by the widow of a former professor of anatomy and named in his honor the Robert Laughlin Rea professorship. N. S. Davis, Jr., son of the illustrious founder, became dean in 1901; an office he filled until 1907. In 1910 James A. Patten, philanthropist, established an endowment of approximately one-half million dollars, the income of which was to be used for research in bacteriology.

In 1913 plans were discussed by the trustees of Northwestern University for the opening of a downtown campus to provide for all the professional schools of the university. In 1917 an option was secured on a site located on Lake Shore Drive at Chicago Avenue, and June 15



Photograph by Fowler

Northwestern University McKinlock Campus The Medical School, The Montgomery Ward Memorial, in left foreground Passavant Memorial Hospital to right

1920 the nine acre tract was purchased by the University at a cost of \$1,420,260.00. This purchase was made possible by the activities of Mr. William A. Dyche, business manager of the University, and the generosity of Mr. Milton H. Wilson.

In 1921 a gift of \$250,000.00 was made to the University by Mr. and Mrs. George A. McKinlock in memory of their son, George Alexander McKinlock, Jr. By order of the board of trustees the new Chicago campus was named the Alexander McKinlock Jr. Memorial Campus, in honor of Alexander McKinlock Jr. and his comrades who lost their lives during the World War.

In December, 1923 Mrs. Elizabeth J. Ward widow of Chicago's great merchant, gave \$1,000,000.00 to Northwestern University for the erection of a memorial to her husband A. Montgomery Ward. Shortly thereafter this gift was augmented by three millions, the sum to be used for a building to house the medical and dental schools. In 1926 Mrs. Ward added to her previous gifts \$4,000,000.00, which last sum was to be used for endowment, scholarships, and fellowships. In making her initial gift Mrs. Ward said

It has been called to my attention that Northwestern University has recently acquired a site for an urban campus on the lake shore at Chicago Avenue designated to accommodate a medical center a school of commerce, a school of law and other departments, all housed in suitable buildings. This campus offers opportunities particularly appropriate for the memorial which I have had in mind.

It is my belief that Chicago, situated as it is in the center of the district rich in agricultural and natural resources in the United States, protected by the pendulum of Lake Michigan, is destined to become a great city including in its greatness permanent centers for all forms of philanthropic and educational work. Northwestern University the first university founded within the City of Chicago has been steadily developing but with its plans for future growth will more fully realize its opportunities and continue to develop as the city develops.

Endowed universities seem to me to be the most enduring of all human institutions, and Northwestern University by its location and by its history seems destined to endure.

I have selected as a memorial the medical center because of its commanding site overlooking the lake because it will render a very large measure of service to humanity and because it will be as enduring a memorial as can be devised.

The plan taken as a whole seems to me to make adequate provision for centers of medicine, law and commerce, with ideals of quality rather than quantity.

The new medical center of Northwestern University shall conduct approximately the following activities

Instructional To impart available medical and related knowledge to students, internes, postgraduates, nurses, and social service workers.

Humanitarian To advance the frontiers of medical and related knowledge through research, to acquire knowledge of the natural history of disease, leading to the prevention of disease and to improve existing methods of treating disease.

Civic To render community health service by promoting periodic medical examination, also, by efforts to readjust the occupational and social life of those in the incipient stages of disease and by the treatment of disease.

The ground breaking ceremonies were held May 8 1925 a day selected because it marked the seventy fifth anniversary of the founding of Northwestern University. This building is the present home of the medical school which occupies the first seventh and fourteenth floors of the building proper of the third and fifth floors in the tower. The obstetric department has been carefully planned to take care of over 130,000 patients in an adequate room is furnished for didactic and research work, 89 students being engaged in the phase of medical education.

In 1905 William S. Cutter formerly dean of the medical school of the University of Nebraska came to Northwestern at Northwestern University.

In 1906 a donation was effected with Passavant Memorial Hospital and in 1909 this institution erected a \$1,000,000 dollar building on the Medical Campus. In 1930 the Evanston (Ill.) Hospital also was affiliated. These two hospitals together with Wesley Hospital, now constitute a triad where clinical instruction is carried on the staffs being named by the medical school. Other Chicago institutions where clinical instruction is received by the students are St. Luke's, Michael Reese Children's Memorial, St. Joseph's, Cook County Norwegian American and Illinois Masonic Hospitals.

The Archibald Church Library, endowed by Archibald and Margaret Finch Church, now numbers more than 60,000 bound volumes and contains many of the classics of medicine, as well as considerable source material.

Since its establishment in 1859 Northwestern University Medical School has graduated 519

physicians of whom approximately 3,900 are living and are in active practice. Among the many distinguished graduates may be mentioned Dr. James S. Jewell, founder and first editor of the *Journal of Nervous and Mental Disease*, Frank Billings, prominent internist and medical educator, Charles Mayo, joint founder of Mayo Foundation for Medical Education and Research, Franklin Martin, who established SURGERY, GYNECOLOGY AND OBSTETRICS and organized the Clinical Congress of Surgeons of North America and the American College of Surgeons, Joseph B. DeLee, founder of Chicago Lying In Hospital and author of *Principles and Practice of Obstetrics*, Howard T. Ricketts, who discovered the role of the wood tick and body louse in transmission of Rocky Mountain Spotted Fever and Mexican typhus, Isaac A. Abt, author of *System of Pediatrics*, Allen B. Kanavel, author of *Infections of the Hand*, John A. Fordyce, editor of *Archives of Dermatology and Syphilology*, professor of dermatology at College of Physicians and Surgeons, New York, Charles D. Lockwood, one of the founders and first president of Pacific Coast Surgical Association and Nicholas Senn, prominent Chicago surgeon.

As from the beginning, instruction has been consistently maintained at a high level, representing the best in laboratory and clinical science. The emphasis has been and is on training physicians for the practice of medicine, although research is fostered and stimulated to an unusual degree. One hundred twenty students are accepted in each of the first two years of the medical course proper and 130 in each of the two clinical years.

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CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

WILLIAM D. HAGGARD Nashville, *President*

ROBERT B. GREENOUGH, Boston, *President Elect*

FRANKLIN H. MARTIN Chicago *Director-General*

ARTHUR W. ALLEN *Chairman* ERNEST M. DALAND *Secretary Committee on Arrangements*

PRELIMINARY PROGRAM FOR CLINICAL CONGRESS IN BOSTON

IN the following pages will be found the preliminary program of clinics and demonstrations as prepared by the Committee on Arrangements for the twenty-fourth annual Clinical Congress of the American College of Surgeons to be held in Boston October 15-19. The surgeons of that great medical center have organized under the leadership of a strong and representative committee and are planning to provide for the Fellows of the College and their guests a program of surgical clinics that will present a complete showing of their clinical activities in all departments of surgery. The Committee on Arrangements has been assured of the hearty cooperation of the clinicians at the medical schools and more than thirty hospitals that will participate in the program.

It will be noted that operative clinics and demonstrations in the hospitals are scheduled for the afternoon of Monday, October 15, beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days. The schedules here published are to be revised and amplified as the work of the Committee progresses during the intervening weeks. The real program will be published daily during the Congress—a complete and accurately detailed program to be posted in the form of bulletins at headquarters each afternoon for the succeeding day. The same material is to be issued in printed form the following morning.

Many special features will be included in the clinical program among them being (1) Cancer clinics demonstrating the treatment of cancer by surgery, radium and the X-ray, (2) fracture clinics at which modern methods in the treatment of fractures will be demonstrated, (3) clinics in traumatic surgery for the presentation of methods used in the rehabilitation of injured patients by surgery and physiotherapy.

The Committee on Scientific Exhibits has drawn upon the abundant medical resources of Massachusetts to provide a remarkably attractive and instructive exhibit for the benefit of the Fellows. At headquarters and in the medical institutions of Boston there will be presented unusual exhibits on various phases of historical and current events in the practice of surgery and its specialties, deontology, anatomy, pathology, public health and anesthesia. An exceptional feature will be an exhibition of works of art by Massachusetts physicians.

EVENING MEETINGS

The Central Executive Committee has prepared programs for five evening sessions which are published in the following pages. At the presidential meeting on Monday evening in Symphony Hall, the president-elect, Dr. Robert B. Greenough, of Boston, will deliver his inaugural address. A feature of this session will be the John B. Murphy oration in surgery by Dr. Donald C. Balfour of Rochester, Minn.

A number of distinguished surgeons from abroad who will be in attendance at the Clinical Congress will be introduced at this session. Among the visiting surgeons will be the following: Dr. Bethel Solomons, Dublin, Ireland; Sir Harold Gilles and Mr. A. Lawrence Abel, London, England; Mr. Harry Platt and Dr. William F. Shaw, Manchester, England; Dr. Alexander MacLennan, Glasgow, Scotland; Dr. Rafael Silva, Mexico City, Mexico; Prof. Josef Halban, Vienna, Austria.

On Tuesday, Wednesday and Thursday evening sessions will be held in the ballroom of the Copley Plaza Hotel at which eminent surgeons of the United States and Canada together with visiting surgeons from foreign countries will present and discuss papers on surgical subjects of timely importance.

At the annual Convocation of the College to be held on Friday evening in Symphony Hall, the 1934 class of candidates will be received into Fellowship in the College.

SYMPOSIUM CANCER IS CURABLE

Further reports by clinicians from various parts of the United States and Canada, presenting additional statistics on the cure of cancer in addition to reports presented at the 1932 and 1933 sessions of the Clinical Congress, will be included in a symposium on cancer to be presented under the auspices of the Committee on the Treatment of Malignant Diseases in the ballroom of the Copley Plaza Hotel on Wednesday afternoon. The program for the symposium follows:

CHARLES A. DUKES, M.D. Oakland, Calif. presiding
General Subject of Curability of Cancer FRANKLIN H. MARTIN, M.D. Director General
General Cases of Five Year Cures ROBERT S. CATWRIGHT, M.D. Charleston, S. C. ROY D. McCLEURE, M.D. and ARTHUR MCGRAW, M.D. Detroit, MORT R. REID, M.D. and WILLIAM MILLER, M.D., Cincinnati; HARRY C. SALTZSTEIN, M.D. Detroit, FRANCIS CARTER WOOD, M.D. and BENJAMIN RICK SMOKE, M.D. New York.
Cancer of the Stomach and Intestines WILLIAM T. COOGLIN, M.D. St. Louis
Cancer of the Pelvic Organs and Breast FREDERICK C. HOLNEY, M.D. New York C. JEFF MILLER, M.D. New Orleans
Cancer of the Breast HUBERT A. ROYSTER, M.D. Raleigh, M. C. HUGH H. TROUT, M.D. Rouseke Va.
Cancer of the Pelvic Organs FREDERICK J. TATUM, M.D. St. Louis
Cancer of the Genito-Urinary Organs EDWIN BEER, M.D. New York
Cancer of the Mouth and Larynx GORDON B. NEW, M.D. Rochester, Minn.
Lymphatic Tumors LLOYD F. CRAVER, M.D. New York

Following these reports a group of papers descriptive of accepted methods for the treatment of cancer will be presented as follows:

Cancer of the Stomach Treated by Surgery J. SKEELTON HOWLEY, M.D. Richmond, Va.
Cancer of the Cervix Treated by Surgery and Irradiation GEORGE GRAY WARD, M.D., New York
Cancer of the Breast Treated by Surgery and Irradiation STUART W. HARRINGTON, M.D. Rochester Minn.
Cancer of the Lip Treated by Surgery and Irradiation ELLIS FRICKEL, M.D. St. Louis
Cancer of the Bladder Treated by Surgery and Irradiation WILLIAM E. LOWE, M.D., Cleveland

FRACURE CONFERENCE

A conference on fractures, under the auspices of the College Committee on the Treatment of Fractures, will be held in the ballroom of the Copley Plaza Hotel on Tuesday afternoon.

Among the papers to be presented are
One Thousand Consecutive Fractures of Both Bones of the Leg WILLIAM SPOFFORD, M.D., in collaboration with J. SNEY NORMAN, M.D. Pueblo, Colo.

Treatment of Fracture of the Carpal Scaphoid D. W. GORDON MURRAY, M.D. Toronto
Fractures of the Jaw ROBERT H. ILL, M.D. Philadelphia
Acute Fractures MELVIN S. HENDERSON, M.D. Rochester Minn.
Further Observations of the Nicola Operation for Recurrent Dislocation of the Shoulder TOURNET NICOLA, M.D. New York

Also under the auspices of the same Committee, by the use of manikins, splints, tables, and other accessory equipment hundreds of treated fractures will be practically demonstrated daily as a part of the scientific exhibition in the Statler Hotel ballroom.

CONFERENCE ON INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

During the past four years the College has conducted investigations and surveys in many parts of the United States to ascertain present medical conditions in industry and to inform employers of adequate methods. The results of these surveys will be presented in the symposium to be held in the ballroom of the Copley Plaza Hotel on Friday afternoon under the auspices of the Board on Industrial Medicine and Traumatic Surgery. Other papers in the symposium deal with the clinical aspects of injuries occurring in industry and methods of rehabilitation of the injured.

FREDERIC A. BRIDLEY, M.D. Chairman, Board on Industrial Medicine and Traumatic Surgery presiding
The Program of the American College of Surgeons in Industrial Medicine and Traumatic Surgery FRANKLIN H. MARTIN, M.D. Chicago, Director-General
A Four Years Survey of Medicine and Surgery in Industry M. N. NEWCOMB, M.D., Chicago
The Value of an Organized Medical Service in an Industrial Establishment HOMER L. FERGUSON, President, Newport News Shipbuilding and Dry Dock Company Newport News, Va.
Papilloma and Carcinoma of the Bladder Among Dye Workers GEORGE H. GERRARD, M.D. Medical Director E. I. du Pont de Nemours & Company Wilmington, Del.
Back Injuries FREDERIC J. COTTON, M.D. Boston
Reconstruction Surgery SIR HAROLD GILLIES, C.B.E. F.R.C.S. London

OPHTHALMOLOGY AND OTOLARYNGOLOGY

The committee in charge of the section on surgery of the eye, ear, nose, and throat has arranged a program of ophthalmological and otolaryngological clinics and demonstrations at the hospitals and medical schools. This appears in the following pages, and in addition programs for sessions on Tuesday, Wednesday, Thursday and Friday afternoons in John Hancock Hall, located on St. James Avenue midway between the Statler and Copley Plaza Hotels. At these sessions distinguished specialists will present papers on subjects of timely interest.

A symposium on 'Diseases of the Esophagus' will be presented on Thursday afternoon at 3 30 in the ballroom of the Copley Plaza Hotel following the annual meeting. The program follows:

An X-ray Study on Lesions of the Esophagus (statistical study with lantern slides) A S MACMILLAN
Infection of the Esophagus in Acute and Chronic Disease
Fibrosis of the Terminal Portion of the Esophagus (Cardiospasm) Etiology and Treatment. HARRIS P MOSHER
The Surgical Approach to the Esophagus EDWARD D CRUICKSHANK

COMMUNITY HEALTH MEETING

Following its established custom and in recognition of its obligation to the public to provide authoritative information on modern surgery, better hospitals, and the prevention of disease, a community health meeting will be held on Wednesday evening, October 17, under the auspices of the American College of Surgeons in connection with the Clinical Congress. For this purpose the Boston Arena, which accommodates approximately 10 000 people, has been engaged. A program appropriate for the occasion has been prepared consisting of brief interesting talks on scientific medicine, health and hospitals. These talks will be supplemented by an interesting new sound motion picture on modern hospital care.

ROBERT B GREENOUGH, M D Boston President, American College of Surgeons, presiding
The American College of Surgeons—Its Aims and Objects
FRANKLIN H BLARTIN, M D Chicago Director General
A Century of Progress in Medicine. ALLEN B KAMARSKY, M D, Chicago.
The Role of Experimental Medicine in Human Surgery
GEORGE W CLEGG, M D Cleveland.
Maternal Care in Approved Hospitals MALCOLM T MACLEACH, M D Chicago
Cancer—Its Prevention and Control CLARENCE COOK LITTLE, Sc D New York.
Cancer—Its Curability CHARLES A DUKES, M D Oakland, Calif.
The Care of the Injured FREDERIC A BENLEY, M D Waukegan Ill.
The Ache in Your Back. PHILIP H KREDSCHER, M D Chicago.
Doctors, Hospitals, and Patients. ROBERT JOLLY HOUSTON, Texas.
Motion Picture—"Good Hospital Care."

ANNUAL HOSPITAL CONFERENCE

A highly practical and instructive four-day program has been prepared for the seventeenth annual hospital standardization conference during the Clinical Congress in Boston. The program appears in the following pages. Administrative, economic and educational topics will be presented by leaders in the hospital field including surgeons, trustees, administrators, nurses and research

workers. These addresses will be supplemented by round table conferences and demonstrations in three of Boston's leading hospitals on Tuesday, Wednesday and Thursday afternoons.

At the opening session on Monday morning distinguished leaders in medical and hospital work will address the conference, the topics to be discussed tending to focus attention on present day problems related to hospital standardization and administration. Other sessions will be devoted to a discussion of major problems of concern to all hospitals—sterilization of surgical dressings, instruments and supplies, and standards for maternal care. Both subjects are now attracting widespread interest, and it is planned to present at these sessions the latest authentic facts pertaining thereto, expecting that such discussions will lead to a definite understanding as to the best standards to be adopted. At a special session on Tuesday evening in the Georgian Room of the Statler Hotel, a comprehensive analysis of the duties and responsibilities of the hospital trustees will be presented.

During recent years there has been a notable increased interest in hospital matters aroused through economic conditions. The problem of giving the patient the best scientific service possible at the lowest cost has seriously engaged the interest of all groups. Attention will be focused on this problem during the four-day conference. Physicians, trustees, administrators, nurses and others will have an opportunity at this meeting to discuss the many problems of mutual concern.

OTHER FEATURES OF THE PROGRAM

Surgical motion picture films, both sound and silent, will be exhibited daily in the Georgian Room at the Statler Hotel. Many new films will be shown. The showing of films demonstrating clinical features of interest has met with popular acceptance in recent years and will be continued at this session with an enlarged program.

Ether Day will be celebrated at the Massachusetts General Hospital on Tuesday with special exercises at 4 p.m. in the dome room of the old building of the hospital where ether was first administered for the production of surgical anesthesia on October 16, 1846.

HEADQUARTERS

The Statler and Copley Plaza Hotels will be utilized as headquarters for the Congress. At the former the grand ballroom and adjoining assembly room together with other large rooms on the mezzanine floor have been reserved for the exclusive use of the Congress for registration and

clinic ticket bureaus bulletin boards, technical exhibition, and executive offices. A scientific exhibit, which will be arranged by the local committee, is to be installed in the balcony of the ballroom. At the Copley Plaza Hotel the grand ballroom will be utilized for evening scientific meetings, hospital conferences, and other large gatherings daily.

The technical exhibition will be located in the ballroom and adjoining assembly room at the Statler Hotel. The registration and clinic ticket desk, together with the information bureau will be located in these rooms in which will also be found the bulletin boards on which the daily clinical programs will be posted each afternoon. The leading manufacturers of surgical instruments, electrosurgical and X-ray apparatus, operating room lights, tables, sterilizers, hospital apparatus and supplies of all kinds, ligatures, dressings, pharmaceuticals, and publishers of medical books will be represented in this exhibition.

ADVANCE REGISTRATION

The hospitals and medical schools of Boston afford accommodations for a large number of visiting surgeons, but to insure against overcrowding attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore, that those surgeons who wish to attend the Clinical Congress in Boston will register in advance by applying to the offices of the College in Chicago.

Attendance to all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding, as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non-transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

BOSTON HOTELS AND RATES

Boston hotels will provide ample facilities and there should be no difficulty in securing first-class accommodations. It is advisable, however for those who expect to attend the Clinical Congress to reserve their accommodations as far in advance as possible. In addition to the headquarters hotels, the Statler and Copley Plaza, there are a number of first-class hotels within walking distance of headquarters. The following list of hotels with their rates has been prepared by the local committee.

	Minimum Rates 11th Month	
	Single	Double
Bellevue, 21 Beacon Street	\$3.00	\$5.00
Bradford, 273 Tremont Street	\$3.50	\$5.50
Bracecomb, 404 Commonwealth Avenue	3.00	4.00
Brunswick, 520 Boylston Street	2.50	4.00
Backmaster, 645 Beacon Street	2.00	3.50
Canterbury, 14 Charlestown West	\$3.50	3.00
Charlestown, 335 Beacon Street		4.00
Copley Plaza, 158 St. James Avenue	4.00	6.00
Fenaghty, 534 Beacon Street	\$3.50	3.50
Graylyn, 20 Charlestown West		5.00
Hancockway, 91 Westland Avenue	\$3.50	3.50
Kennedy, 400 Commonwealth Avenue	3.00	4.50
Lenox, Essex Street	\$3.50	3.50
Lincolnshire, 20 Charles Street	3.00	4.50
Manger, North Station	\$3.50	3.50
Parlor House, 60 School Street	3.00	4.50
Pennant, 300 Commonwealth Avenue	3.50	5.00
Rita-Carlton, 15 Arlington Street	4.00	7.00
Sheraton, 91 Bay State Road	3.00	4.00
Somerset, 400 Commonwealth Avenue	3.00	3.50
Statler Park Square	3.50	5.00
Townsend, 65 Boylston Street	3.00	5.00
Vendome, 150 Commonwealth Avenue	\$3.50	4.00
Victoria, 271 Dartmouth Street	3.00	5.00
Westminster, 124 St. James Avenue	\$3.50	3.50

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Boston session of the Clinical Congress so that the total fare for the round trip will be one and one-third the ordinary first-class one way fare. To take advantage of the reduced rates it is necessary to pay the full one way fare to Boston, procuring from the ticket agent when purchasing ticket, a "convention certificate" which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of the viséd certificate to the ticket agent in Boston not later than October 23 a ticket for the return journey by the same route as traveled to Boston may be purchased at one third the one way fare.

In the eastern, central, and southern states and eastern provinces of Canada tickets may be pur-

chased between October 11 and 16 in other sections of the United States and Canada at earlier dates. The return journey must be completed within thirty days from date of sale of ticket to Boston.

The reduction in fares does not apply to Pullman fares nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, routes, etc. Stop-overs may be had within certain limits.

Full fare must be paid from starting point to Boston, and it is essential that a 'convention certificate' be obtained from the agent when the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and viséd by a special railroad agent at Clinical Congress headquarters on or before October 19. No reduction in railroad fares can be secured except in compliance with the regulations

outlined and within the dates specified. It is important to note that the return trip must be made by the same route as used in going to Boston that the certificate must be viséd at headquarters during the meeting and return ticket purchased not later than October 23.

In the western and southwestern states, including the Pacific coast states and the western provinces of Canada the railroads have authorized the sale of round trip tickets to Chicago at very low rates on account of A Century of Progress Exposition so that persons from the west traveling through Chicago to Boston will find it to their advantage to buy round trip tickets to Chicago at the low rates in effect on account of the Exposition. Under this plan it will be necessary to purchase tickets to Boston from Chicago taking advantage of the convention certificate plan outlined above. Ticket agents should be consulted with regard to special rates.

SCIENTIFIC EXHIBITS

AT HEADQUARTERS STATLER HOTEL

FRACTURES. Demonstrating methods of treating fractures, under the auspices of the New England Fracture Committee of the American College of Surgeons.

PLASTIC SURGERY. An exhibit of models, photographs, and diagrams, illustrating the different methods employed in plastic surgery and the results.

TRAUMATIC SURGERY. Diagrams, photographs, and charts.

ORTHOPEDIC SURGERY. An exhibit of splints and other forms of orthopedic apparatus, together with charts and photographs.

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH. An exhibit illustrating the activities of this department.

CANCER. An exhibit from the Palmer Memorial Hospital, Collis P. Huntington Memorial Hospital, and the Pondville State Cancer Hospital. Lantern slides, charts, and photographs illustrating cancer of the various organs of the body, the diagnosis and the results obtained by different forms of treatment. Also, an exhibit of specimens of cancer from many parts of the body.

OPHTHALMOLOGY. Charts and photographs illustrating melanotic sarcoma and other conditions of the eye. Heredity of immune reactions. Hereditary blindness. Pedigree of blindness.

PATHOLOGY. The specimens removed at operations from the various hospitals in the morning will be collected and placed on exhibition in artificially cooled show cases in the afternoon, in a room adjoining the Geor-

gan Room. At 5 p. m. these specimens will be demonstrated in the Georgian Room by a projectoscope, the microscopic sections shown, and the cases discussed.

AT HOSPITALS AND MEDICAL INSTITUTIONS

HARVARD DENTAL SCHOOL. An exhibit of models, photographs, and diagrams showing the restoration of extensive defects and deformities of the face and jaws by plastic surgery and dental prosthesis, including cases of soldiers wounded in the World War.

BOSTON MEDICAL LIBRARY. Exhibit of historical books on surgery and anatomy and surgical medals. Historical pageant illustrating the development of surgery. Wednesday, October 17, John Ware Hall, 4 p. m., presented by the students of Tufts College Medical School under the direction of Professor B. Spector. Exhibition of works of art by Massachusetts physicians under auspices of the Physicians Art Society.

MASSACHUSETTS GENERAL HOSPITAL. Daily at noon, an exhibit in the Ether Dome relative to the first public demonstration of ether anesthesia including a showing of the motion picture 'The First Public Demonstration of Ether Anesthesia.' Also the motion picture film 'Fractures in Transportation.'

MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY. Anatomical specimens and otolaryngeal instruments.

HARVARD MEDICAL SCHOOL, Warren Museum. Anatomy anatomical specimens pathology pathological specimens.

OPHTHALMOLOGY AND OTOLARYNGOLOGY—SCIENTIFIC SESSIONS

Tuesday—John Hancock Hall 2—Ophthalmology

- JOHN M. WHEELER, New York. Plastic ophthalmic surgery. Discussion opened by W. B. LANCUTTER.
- JOSIAS S. FREEDMAN, Baltimore. Slit lamp ophthalmoscopy. Discussion opened by J. H. WATTE.
- CLARENCE KING, Cincinnati. Tubercula in the treatment of ocular tuberculosis. Discussion opened by MERRILL KING.
- RAFAEL SILVA, Mexico City. Subject to be announced.

Wednesday—John Hancock Hall, 2—Otolaryngology

- THOMAS E. CARMODY, Denver. Congenital deformities of the face and neck. Discussion opened by V. H. KAFANTJIAN.
- LOUIS H. CLEGG, Philadelphia. Peroral endoscopy in otolaryngological practice.
- SAMUEL J. CROWE, Baltimore. Ménstré's syndrome complex. Discussion opened by PHILIP MELTZER.
- JOHN R. PAGE, New York. Acute infections of the middle ear and mastoid.
- O. JAMES DYER, Kansas City. A departure in the management of acute mastoid disease or the advantages of conservative treatment in acute mastoid disease. Discussion opened by LYMAN RICHARDS.
- GEORGE M. COATES, Philadelphia. Diagnosis of chronic infection of the tonsils in relation to indications for operation in cases of chronic focal infection.
- WILLIAM V. MULLIN, Cleveland. Present status of infection of the upper respiratory tract in its relation to focal infection. Discussion opened by H. ARCHIBALD NISBET.
- EDWARD ZERTELMAN, San Francisco. The clinical and surgical significance of the component cellular characteristics of the temporal bone based upon a series of 100 cadaver and autopsy observations, lantern slide demonstration.

Thursday—John Hancock Hall 2—Ophthalmology

- LUTHER C. PETER, Philadelphia. The technique of orthoptic training in strabismus. Discussion opened by DAVID MILLS.
- HARRY S. GRADLE, Chicago. Recent therapeutic procedures. Discussion opened by ALLEN GREENWOOD.
- WILLIAM L. BRIDGEMAN, Rochester, Mass. Subject to be announced. Discussion by W. MILLER LORAIN.
- C. N. SPRATT, Minneapolis. Closure of the cataract incision (motion pictures).

Ballroom, Copley-Plaza Hotel—5:30—Otolaryngology

- A. S. MACMILLAN. An X-ray Study on Lesions of the Esophagus (statistical study with lantern slides).
- HARRIS P. MONSTER. Infection of the Esophagus in Acute and Chronic Disease, Fibrosis of the Terminal Portion (Carcinomas). Etiology and Treatment.
- EDWARD D. CRUNCHILL. The Surgical Approach to the Esophagus.

Friday—John Hancock Hall 2—Otolaryngology

- SAMUEL J. KOPPEL, New York. Recent developments in the diagnosis of meningitis.
- WILLIAM P. EAGLETON, Newark, N. J. Meningitis—result of disease of the petrous apex and sphenoidal base.
- MARTIN F. JONES, New York. Pathways of approach to the petrous pyramid. Discussion by HARRY F. CARILL.
- WILLIAM MITCHELL, Cincinnati. When and how shall a nasal sinus inflammation be treated surgically?
- EDWARD C. SEWELL, San Francisco. Operative treatment of adenitis, external approach. Discussion opened by CHARLES T. PORTER.
- GABRIEL TUCKER, Philadelphia. Cancer of the larynx.
- HENRY B. ORTOW, Newark, N. J. Cancer of the laryngopharynx. Discussion opened by LEROY A. SCHALL.

PRELIMINARY PROGRAM FOR EVENING MEETINGS

Presidential Meeting—Monday—October 15 8 15 p m

Address of Welcome ARTHUR W ALLEN M D Boston Chairman, Committee on Arrangements
 Introduction of Foreign Guests FRANKLIN H. MARTIN M.D., Chicago, Director General
 Address of Retiring President WILLIAM D HAGGARD M D Nashville Tenn.
 Inauguration of Officers
 Inaugural Address. ROBERT B GREENOUGH M D Boston
 John B. Murphy Oration in Surgery Principles of Gastric Surgery DONALD C BALFOUR, M.D. Rochester Minn.

Tuesday—October 16 8 15 p m

Living Grafts of Thyroid and Parathyroid Glands. HARVEY B STONE M D Baltimore with the collaboration of JAMES C. OWINGS, M.D. and GEORGE O GUY M D Baltimore
 Endocrine Mechanisms in Certain Functional Gynecological Disorders. EMIL NOVAK, M.D., Baltimore
 Fracture Oration The Unsolved Fracture. KELLOGG SPEED M.D. Chicago
 The Giant-Cell Tumor of Bone as a Clinical Entity HARRY PLATT M.S. F.R.C.S. Manchester England

Wednesday—October 17 8 15 p m

Hydrocephalus and Spina Bifida. WILDER PENFIELD M D Montreal
 Sterility with Special Reference to Surgical Possibilities. BETHEL SOLOMONS M D, F.R.C.P.I. Dublin, Ireland
 Diverticulosis and Diverticulitis. IRVIN ABELL, M.D. Louisville

Thursday—October 18 8 15 p m

Symposium on Treatment of Infections
 Infections of Clean Operative Wounds. FRANK L. MELENEY M.D. New York
 Infections of the Lip and Face. FREDERICK A. COLLIER, M.D. Ann Arbor Mich.
 Phagedenic Ulcer its Recognition and Treatment. EMILE HOLMAN M.D., San Francisco
 The Repairs of Defects Resulting from Full Thickness Loss of Skin from Burns. JAMES B. BROWN M.D. St. Louis

Convocation—Friday—October 19 8 15 p m

Invocation. REV CHARLES WESLEY BURNS, D D LL.D., Boston
 Presentation of Candidates for Fellowship FRANKLIN H. MARTIN M D Chicago Director General
 Conferring of Fellowships. The President
 Conferring of Honorary Fellowships. The President
 Presidential Address. ROBERT B GREENOUGH M.D., Boston
 Fellowship Address

ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

Monday 9 30-12 30—Ballroom Copley-Place Hotel

Chairman's Address WILLIAM D. HAGGARD, M.D. Nashville, Tenn.

Presentation of Seventeenth Annual Hospital Standardization Report FRANKLIN H. MARTIN, M.D. Chicago

Guiding Fundamental Principles for Prepayment of Hospital and Medical Services CHARLES A. DUKES, M.D. Oakland, Calif.

The Development of Periodic Prepayment Plans for Hospital Care in England SYDNEY LAMB, Liverpool, England

The Hospital in Retrospect and Introspect REV. ALFRED M. SCHWARTZ, S.J. Ph.D. St. Louis

Future Trends in Hospital Management and Service BERT W. CALDWELL, M.D. Chicago

The Proper Interpretation of Hospital Service NEWTON E. DAVIS, D.D. Columbus, Ohio

What the Hospital Can Do for the Younger Surgeon WITTEN B. RICE, M.D. San Antonio, Texas

Principles Governing Relation of Radiologists to Hospitals, ARTHUR C. CHRISTIE, M.D. Washington, D.C.

Monday 2 00-5 00—Ballroom Copley-Place Hotel

Standards for Obstetrical Service in Hospitals GEORGE W. HOMAK, M.D. New York, presiding.

A Study of Obstetric Complications in the Woman's Hospital to Establish Proper Standardization for Statistical Purposes GEORGE GRAY WARD, M.D. BRYON H. GORT, M.D. and ALBERT H. ALDEN, M.D. New York

Regulations and Control of Obstetrical Practices in Institutions by Nonstaff Physicians SAMUEL A. CONROVE, M.D. Jersey City, N.J.

Minimum Standards of the American College of Surgeons for the Care of Obstetrical Patients in General Hospitals ROBERT A. JOHNSON, M.D. Houston, Texas

General discussion led by JAMES RAULAN MILLER, M.D. Hartford, Conn.

Tuesday 9 30-12 30—Ballroom, Copley-Place Hotel

Sterilization of Dressings, Instruments, and Supplies G. HARVEY ADELMAN, M.D. Toronto, Ont. presiding

Observations on Sterilization of Dressings with Specific Reference to Sterilizing Chamber Temperatures and Their Relation to Sterilizer Chart Temperatures and Cultures SAMUEL R. D. HEWITT, M.D. St. John, N.B.

A Scientific Analysis of Steam in Sterilizing Showing How Precision Methods May Be Substituted for the Indefinite Methods now in Vogue. WILSON B. JAMES, Wood End, Pa.

Checking and Controlling Postoperative Infections HAROLD L. FORD, M.D. Danville, Pa.

The Fundamental Principles Underlying the Mechanics and Technique of Sterilization HURLEY T. WYATT, M.S. Madison, Wis.

General discussion opened by CLAUDE W. MURDER, M.D. Valhalla, N.Y.

Tuesday 2 00-5 00—Massachusetts General Hospital

ROBERT JOLLY HOUSTON, Texas, presiding

Demonstrations and round table discussions in hospital standardization and administration, conducted by GEORGE H. BRADLOW, M.D. Director and heads of departments

Tuesday 8 00-10 00 p.m.—Georgian Room, Statler Hotel

Special Session for Hospital Trustees

C. P. CURTIS, Boston, presiding

How I View my Responsibility as a Hospital Trustee IDA M. CANNON, Boston

How I Discharge my Duties as a Hospital Trustee FULLER BARRETT, Bristol, Conn.

General discussion led by JOSEPH C. DOANE, M.D. Philadelphia

Motion Picture—"Good Hospital Care" (sound)

Wednesday 9 30-12 30—Ballroom Copley-Place Hotel

Joint Session with Association of Record Librarians of North America JAMES T. AVE, M.D. New Orleans, presiding

The Use of the National Nomenclature H. B. LOOMIS, M.D. New York

Basic Training for a Record Librarian JENNIE N. HARRIS, Rochester, N.Y.

The Organization and Management of the Medical Records Department in a Sisters' Hospital SURGEON M. PATRICK, Duluth, Minn.

Round table conference—problems connected with clinical records, with special discussion of uses of clinical records. Conducted by ALLAN CRAIG, M.D. Torrington, Conn.

Wednesday 2 30-5 00—St. Elizabeth's Hospital

MALCOLM T. MACEachern, M.D. Chicago, presiding

Demonstrations and round table discussions in hospital standardization and administration. Conducted by REV. THOMAS J. BISHOPMAN, Superintendent, and heads of departments

Thursday 9 30-12 00—Ballroom Copley-Place Hotel

Round table conference. Conducted by ROBERT JOLLY HOUSTON, assisted by MALCOLM T. MACEachern, M.D. Chicago

There will be a clearing house for all questions arising out of the deliberations of the previous sessions and problems in the minds of any present, in addition to a special program of fifty important hospital questions.

Thursday 2 30-5 00—Beth Israel Hospital

ROBERT JOLLY HOUSTON, Texas, presiding

Demonstrations and round table discussions in hospital standardization and administration. Conducted by CHARLES F. WILKINSON, M.D. Director and heads of departments

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY GYNECOLOGY OBSTETRICS ORTHOPEDICS, UROLOGY
PROCTOLOGY, SURGICAL PATHOLOGY ETC

MASSACHUSETTS GENERAL HOSPITAL

Monday

- Staff—1. Dry clinic. A W ALLEN Bleeding peptic ulcer
JOHN STEWART Water balance in the surgical patient
C. M. JONES Nutritional edema. L. S. McKITTRICK
Cancer of rectum. E. L. YOUNG JR. Cancer of colon
J. V. MEIGS and F. W. HOYT Rupture of Graafian
follicle and corpus luteum. R. H. WALLACE Treat-
ment of burns
W. J. MIXTER, JOHN HODGSON and associates—2. Neuro-
surgical clinic.
V. H. KAZANJIAN, E. M. DALAND and associates—2. Plas-
tic surgery clinic.
T. R. GOETHALS and associates—4. Obstetrical clinic

Tuesday

- Staff—9. Operative clinics General surgical genito-ur-
inary and thyroid services
H. C. MARBLE and T. W. HARKER—3. Surgery of the
hand
GEORGE HOLMES, A. O. HAMPTON and associates—3. Sym-
posium on the roentgen ray
E. D. CHURCHILL and associates—3. Surgical research
laboratories, demonstration of specimens and discus-
sions
M. N. SMITH PETERSEN and associates—3. Orthopedic
clinic.
Ether Day exercises—4

Wednesday

- Staff—9. Operative clinics, general surgical, fracture and
circulatory services
Staff—3. Dry clinic D. KING Postoperative pulmonary
complications H. BRADSHAW Methods in anesthe-
sia H. SRAQUE Surgery in cardiac patients. L. S.
McKITTRICK and R. H. MILLER Ulcerative colitis
E. D. CHURCHILL Cardiology. E. B. BENEDICT
Gastroscopy R. H. MILLER Osteomyelitis.
J. V. MEIGS, F. ALBRIGHT and associates—3. Ovarian
dysfunction clinic.
A. W. ALLEN G. A. LELAND and associates—3. Fracture
clinic.
E. P. HAYDEN and associates—2. Proctology

Thursday

- Staff—9. Operative clinics, general surgical and thoracic
services
E. A. COOMAN and associates—9. Symposium on lesions
of the shoulder
T. B. MALLORY—13. Clinical pathological conference.
E. D. CHURCHILL, W. WHITTEMORE and associates—3.
Thoracic surgery clinic.
A. W. ALLEN and associates—3. Circulatory diseases
clinic.
C. C. SHORRON and associates—3. Tumor clinic cancer
symposium.

Friday

- Staff—9. Operative clinics, general surgical and orthopedic
services, neurological operations plastic surgery
Staff—2. Dry clinic. C. LYONS Sympiotic infections B

VINCENT and A. V. BOCK Surgery of spleen A. W.
ALLEN Regional ileitis R. H. MILLER Tuberculosis
of the lymphatic system R. LINTON Perforation of
the cecum complicating carcinoma of colon R. H.
SMITHWICK Gall-bladder disease, correlation of opera-
tive and X-ray findings OLIVER COX Vinland syn-
drome H. ROOPER Pilonidal sinus

J. H. MEANS, A. W. ALLEN E. D. CHURCHILL, R. H.
MILLER, E. L. YOUNG JR. and associates—2. Diseases
of the thyroid and parathyroid

J. D. BARNEY and associates—2. Genito-urinary surgery

CARNEY HOSPITAL

Monday

- HAROLD G. LEE—3. Operative treatment for certain types
of low back pain, demonstration of cases
R. J. HEFFERNAN—3.30. End results following inter-
position for uterine prolapse.

Tuesday

- LOUIS E. PHANEUF—9.30. Vaginal hysterectomy for proci-
denta repair of third degree laceration of perineum.
W. R. MACAULAND—9.30. Arthroplasty of hip elbow or
knee
LOUIS E. PHANEUF—3.30. End results in cervical Cesa-
rean section lantern slide demonstration
ROGER C. GRAVES—3.15. Transurethral resection of the
prostate selection of cases, pre-operative preparation,
operative technique after-care of patient

Wednesday

- F. B. LUND D. F. MAHONEY A. McK. FRASER W. E.
BROWNE and F. J. NASH—9.30. General surgical
operations
W. E. BROWNE—3.45. Demonstration of end-results fol-
lowing treatment for injuries of musculospiral nerve,
posterior Interosseous branch median nerve in fore-
arm ulnar nerve injuries at elbow in mid forearm, at
wrist.
A. LEO BRENT—3.30. Demonstration of patient following
operations for relief of paralysis resulting from myelo-
ma with destruction of tenth dorsal vertebra, moving
picture demonstration of operative technique in spinal
cord tumors

Thursday

- LOUIS E. PHANEUF—9.30. Hysterectomy for fibroids
R. J. HEFFERNAN—10.30. Vaginal operation for proci-
denta uteri vaginal plastic operation for lacerations.
LOUIS E. PHANEUF—3.45. Management of placenta pre-
via, lantern slide demonstration.

Friday

- F. B. LUND D. F. MAHONEY A. McK. FRASER W. E.
BROWNE and F. J. NASH—9.30. General surgical
operations
W. E. BROWNE—3.45. Demonstration of end results fol-
lowing full thickness grafts for contractures in various
parts of forearm and hand Method of preparation
of splints used and various types of splints used in
this work.

BOSTON CITY HOSPITAL

Monday

Staff—2 Dry clinic J J REIDAN S WEISS, and D MURPHY. The eye in arteriosclerosis, hypertension and tumor. O K COOKE. Treatment of shock. J REIDAN and M REIDAN. Pellegrius-Stella's disease, diagnosis and treatment. O J HERMANN and I. PARKER, Jr. Synovitis of knee. F A BLOWACK. Septic hips.

Tuesday

DAVID D. SCHOELLER, SODERFRAKER, THOMAS W. WICKHAM and JOHN A. SATER—9. General surgical dry clinic.

First surgical service—9. General surgical operative clinic. HORACE BUDNEY. Thoracoplasty for unilateral phthisis, phrenoscotomies for unilateral phthisis. JAMES J. HERMANN. Repair of entral hernia. gastric ulcer. GEORGE W. PARKER. Chronic emphysema, cholecystitis.

Fifth surgical service—Dry clinic. IRVING J. WALKER. Some surgical aspects of jaundice—hyperparathyroidism, end-results. repair of common duct chondrocarcoma of humerus, end results, carcinoma of stomach, end-result. ligation of common carotid artery end-result. FRANK F. HENDERSON. Carcinoma of lung; pancreatitis, review of sixty cases. AGOSTINUS RILEY. Prostate and vesicles as foci for retroperitoneal infection. Kidney resections, demonstration of cases. CHARLES C. LUND. Peripheral arterial embolism, results of operative treatment in fifteen cases. E. EVERETT O'NEIL. Breast tumors, clinical versus X-ray diagnosis. WILLIAM A. WHITE. Subject to be announced.

ROBERT M. GREEN, JOSEPH T. WILLIAMS, FREDERICK L. GOOD, JOSEPH P. CONRY and associates—3. Gynecological and obstetrical dry clinic. Treatment of molcarriages. pericervical sepsis. pelvic inflammation.

Wednesday

IRVING J. WALKER, FRANK F. HENDERSON, CHARLES C. LUND, E. EVERETT O'NEIL, and WILLIAM A. WHITE—9. General surgery operative clinic.

Bone and joint service—9. Dry clinic. OTTO J. HERMANN. Boston City Hospital bone and joint service. THOMAS H. PETERSON. Colles' fracture therapy. Scattered traction in ununited fractures of the forearm and old shoulder dislocations. GEORGE K. COOKE. Fracture of the olecranon, new operative repair. OTTO J. HERMANN. Recurrent shoulder dislocations repaired by the Nicols method, end-results, discussion. WILLIAM F. COTTING and MARIA H. RODGERS. Subdeltoid buritis. MARIA H. RODGERS. Rupture of supraspinatus tendon, discussion. JOSEPH H. SHORTELL. Spinal fracture, therapy. RUSSELL F. SULLIVAN. Spinal tumors. OTTO J. HERMANN. Compound fracture therapy. FRANK W. MARVIN. Anesthesia in fractures.

First surgical service—Dry clinic. NEWTON C. BROWN. Results of treatment of Colles' fracture. modern splinting methods in fracture therapy. JAMES J. HERMANN. Results in treatment of peptic ulcer. giant-cell sarcoma of bone. treatment of ventral hernia. HORACE BUDNEY. Methods and results in treatment of acute emphysema, lung abscess, bronchiectasis, pulmonary tuberculosis. GEORGE W. PARKER. Methods and results in treatment of chronic emphysema.

Sixth surgical service—2. Dry clinic. JAMES W. SEVER. Separation of femoral epiphysis. MARIA H. RODGERS. Ankylosed hips. OTTO J. HERMANN. Treatment of intracapsular fractures of neck of femur. demonstra-

tion of cases of recent fractures and ununited fractures. FREDERICK J. COTTON. Pelvic fractures. JOSEPH H. SHORTELL. Bone grafting.

ROBERT M. GREEN, JOSEPH T. WILLIAMS, FREDERICK L. GOOD, JOSEPH P. CONRY and associates—9. Gynecological and obstetrical operations.

Thursday

OTTO J. HERMANN, JOSEPH H. SHORTELL, WILLIAM F. COTTING, RUSSELL F. SULLIVAN, THOMAS H. PETERSON, and G. KENNETH COOKE—9. Operative bone and joint clinic. Ward rounds, demonstration of fracture apparatus, etc.

Second surgical service—9. ROBERT C. COCHRANE. Total thyroidectomy for congestive failure and angina. parathyroid tumors. WILLIAM R. MORRISON. One hundred perforated ulcers of the stomach and duodenum from the Boston City Hospital, stomach surgery. motion picture demonstration. demonstration of following cases—total removal of stomach for cancer with anastomosis of the jejunum to the oesophagus, hour-glass deformity of the stomach, cholecystogastrostomy formed by nature. THOMAS K. RICHARDS. Knee-joint pathology. JOSEPH J. LUCY. Recurrent intussusception caused by intestinal tumor. carcinoma of the sigmoid. RICHARD L. SMITH. Pancreatitis. HERBERT H. HOWARD. End-results of bilateral renal tubercle, importance of postoperative treatment of prostatectomized patient.

Fourth surgical service—2. Dry clinic. ARTHUR R. KNIGHTON. Carbina gas gangrene tetanus; use of anesthetic liquid concentrate. cavernous hemangioma of neck. catheter in common bile duct since 9th. compound fracture. EDWARD HENDERSON. Demonstration of cases. JOSEPH H. BURNETT. Colles' fracture therapy. H. A. BOUD. Acute traumatic abdomen.

Sixth surgical service—3. Bone and joint dry clinic. WILLIAM F. COTTING. Gonorrheal arthritis of the knee. RUSSELL F. SULLIVAN. Halby values therapy. OTTO J. HERMANN. Fractures of the os calcis therapy. discussion. JOSEPH H. SHORTELL. Bone tumors. FREDERICK W. O'BRIEN. Pre- and postoperative X-ray therapy in malignant tumors of the bone. THOMAS H. PETERSON. "Fender" fractures.

ROBERT M. GREEN, JOSEPH T. WILLIAMS, FREDERICK L. GOOD, JOSEPH P. CONRY, and associates—9. Obstetrical and gynecological operations.

Friday

ARTHUR R. KNIGHTON, ROBERT C. COCHRANE, WILLIAM R. MORRISON, STEPHEN P. MALLET and V. H. KAMARJIAN—9. General surgery operative clinic.

Staff—9. Gynecological and obstetrical operations.

Staff—2. Dry clinic. J J REIDAN and W. B. CASTLE. The eye in anemic patients. STEPHEN P. MALLET. Fric-tion of the jaw. WILLIAM R. MORRISON. Visualization of arteries and veins for diagnosis and operation of aneurysm. ligation of the first part of right subclavian artery and subsequent ligation of innominate artery for arteriovenous aneurysm of internal jugular vein and subclavian artery. OTTO J. HERMANN and WILLIAM R. MORRISON. Chronic subclavation of sternal end of clavicle. STEPHEN J. MANOCK. The Hart magnet treatment of chronic osteomyelitis.

Physiotherapy service—9. Dry clinic. JOSEPH REIDAN. Electrodiagnosis. JOSEPH REIDAN, GEORGE W. DICKINSON, ARTHUR J. COLE, WALDO W. ROBINSON, and SIMON M. SCHWARTZ. Demonstration of cases and treatment.

CHILDREN'S HOSPITAL

Monday

W. E. LADD and associates—2. Fractures in children. W. E. LADD Elbow fractures. T. H. LAYMAN Fractures of the femur. P. J. MAHONEY Fractures of both bones of the forearm.

Tuesday

F. R. OBER and associates—9. Orthopedic operations. W. E. LADD—9 30. Plastic repair of harelip and cleft palate, demonstration of cases, motion picture demonstration. THOMAS H. LAYMAN—10. Acute osteomyelitis in infancy and childhood.

PATRICK J. MAHONEY—10 30. The use of various types of skin grafts in children's surgery. HENRY HUDSON JR.—11. Acute appendicitis in childhood. Meckel's diverticulum.

Staff—1. Operative clinic, surgery in infants and children. Staff—3. Orthopedic clinic. A. T. LEOG Early treatment and the prevention of deformities in poliomyelitis. F. R. OBER Shoulder operations. J. W. SEVER Stabilization of the ankle joint. M. KATZOFF Tendon transplants. A. T. LEOG Abductor limp.

Wednesday

F. R. OBER and associates—9. Orthopedic clinic at Pea body Home.

Staff—9 30. Operative clinic. W. E. LADD—2. Congenital hypertrophic pyloric stenosis. Intussusception, diagnosis and treatment.

DONALD W. MACCOLLUM—3 30. Treatment of undescended testes, end results over a 34 year period.

THOMAS H. LAYMAN—3. Chronic pulmonary suppuration, demonstration of cases.

HENRY HUDSON JR.—3 15. Empyema in childhood, its treatment.

SIMEX FARMER—3 30. Surgical pathology of malignant tumors in infancy and childhood, followed by demonstration of pathological specimens in department of pathology.

EDWARD C. VOGT—3 45. Roentgenological studies of unusual bone tumors in infancy and childhood.

Thursday

F. R. OBER and associates—9. Orthopedic operations.

W. E. LADD—9 30. Intestinal atresia, diagnosis and treatment, demonstration of cases, lantern slides.

PATRICK J. MAHONEY—10. Types of tracheo-oesophageal fistule; differential diagnosis and operative treatment. Congenital and acquired oesophageal stricture, demonstration of methods of dilatation.

W. E. LADD—10 30. Atresia of the bile ducts, diagnosis and treatment, choledochus cyst, diagnosis and treatment.

THOMAS H. LAYMAN—11. Ureteral transplantation for ectrophy of the bladder. demonstration of treated cases.

Staff—2. Operative clinic, surgery in infants and children.

Staff—3. Orthopedic clinic. A. H. BREWSTER. Claw feet. F. H. MORRIS. Torticollis, mastoid approach. H. FITZSIMMONS. Discussion. F. R. OBER. Semilunar cartilage. H. FITZSIMMONS. Osteoclasis. R. H. MORRIS. Club feet.

Friday

Staff—9. Orthopedic clinic. S. M. FITCHET. Cleidocranial dysostosis. F. R. OBER. Shelf operations. Sprengel's deformity. S. M. FITCHET. Flexion deformity of the hips. A. T. LEOG. Coxal plana. J. W. SEVER. Obstetrical paralysis.

Staff—9 30. Operative clinic, surgery in infants and children.

W. E. LADD—2. Ulcerative colitis in childhood—diagnosis and treatment. demonstration of cases, lantern slide demonstration.

PATRICK J. MAHONEY—2 30. Treatment of fresh burns. DONALD W. MACCOLLUM—2 45. Treatment of hemangioma by endothermy, demonstration of cases.

W. E. LADD—3. Surgical significance of pyuria in infancy and childhood, demonstration of cases, lantern slide demonstration.

T. H. LAYMAN—3 30. Malignant bladder tumors in childhood.

CAMBRIDGE CITY HOSPITAL

Tuesday

H. H. GERMAIN D. F. MAHONEY E. J. O'BRIEN E. D. ERICCO and E. DOWNEY—9. Dry clinic. H. H. GERMAIN. Results in surgery of the shoulder. nerve suture. partial rupture of posterior cord of brachial plexus. fascial graft for recurrent dislocation of shoulder. arthroplasty of shoulder. arthroplasty for ankylosis of temporomaxillary articulation. skin graft for extensive burns. D. F. MAHONEY. End-results in fracture of pelvis and humerus. E. J. O'BRIEN. End-results in transurethral resection of the prostate. massive diverticulum of the bladder in a child, 3½ years old. E. J. O'BRIEN. X-ray films of injuries to the head and spine. B. A. GOODYN and WALDO ROSSBERG. Orthopedic clinic. end-results in fracture of hip. E. D. ERICCO. Results in injection treatment of varicose veins, moving picture demonstration. E. DOWNEY. Injection treatment of hemorrhoids, methods used and demonstration of cases.

Wednesday

H. H. GERMAIN—9. Surgical operations. Demonstration. Nussbaum operation for leg ulcer (3 cases). tumor of the parotid (2 cases).

Staff—9. Dry clinic. MAXWELL MACDONALD. Encephalography as an aid to diagnosis in cerebral lesions. F. G. MITCHELL and T. E. DODGE. Results of accessory sinus operations, demonstration of cases. R. D. YOUNG. Cesarean section. F. J. LYNCH. To be announced. J. J. MURPHY. Treatment problems of burns in general hospital. J. W. ROCKEY. Oral surgery operations. ARTHUR SARGENT and WILLIAM LAWRENCE. Orthopedic and fracture clinic. F. O. O'BRIEN. Traumatic spine and head injuries, demonstration of X-ray films. J. W. ROCKEY and F. McLEAM. Fractures of lower and upper jaw. M. SHEA. Arthroplasty of lower jaw.

E. J. O'BRIEN and L. ROCKWELL—10 30. General surgical operations.

E. D. ERICCO—2. Acute torsion of great omentum. appendicitis complicating pregnancy.

Thursday

D. F. MAHONEY—9. General surgical operations. J. J. MURPHY—10 30. General surgical operations. problem of rupture of urethra, fracture of pelvis and fracture of femur.

F. O. O'BRIEN—11. Traumatic spine and head injuries, demonstration of X-ray films.

Friday

Staff—9. Operative clinics. Staff—3. Dry clinics.

MASSACHUSETTS MEMORIAL HOSPITAL

Friday

Staff—9. Operative clinics. Staff—3. Dry clinics.

BETH ISRAEL HOSPITAL

Monday

Staff—30 Dry clinic JOHN SEARS Prophylactic vein ligation against embolism from phlebitis of the internal saphenous vein. MYNELL BLOOMBERG The prevention of scar tissue by the use of haudruche experimental and clinical experience, demonstration of cases. WALTER S. LINTON I trapeziocostal adhesions. A LOUIS HOFMANN Translations during active bleeding from peptic ulcer. ALBERT THIRMAN Surgical treatment of cholecystitis. JOSEPH ALLEN Subacute pancreatitis. BENIS RAYMOND Comparison of postoperative complications following spinal and general anesthesia.

Tuesday

Staff—9 Symposium on total thyroidectomy for chronic heart disease and angina pectoris. HERMAN L. BLUMKART Rationale of total thyroidectomy in chronic heart disease. JOSEPH RICHMAN End-results of total thyroidectomy in angina pectoris. DAVID DAVIS End-results of total thyroidectomy in congestive heart failure. HERMAN L. BLUMKART Indications and contra-indications for surgery selection of cases. CHARLES G. MYNTER General surgical considerations in total thyroidectomy. DAVID D. BERLIN Technical considerations in total thyroidectomy. DAVID DAVIS Treatment of postoperative complications. DOROTHY GILLMAN Parathyroid insufficiency following total ablation of the thyroid gland. MARK ALTMAN and ALFRED WEINSTEIN Total thyroidectomy moving picture demonstration demonstration of cases. CHARLES G. MYNTER, D. D. BERLIN and associates—5 Total thyroidectomy.

Wednesday

E. GRANVILLE CHAFFIN and associates—9 Dry clinic, symposium on the female bladder. Demonstration of various factors related to function in health, pregnancy and disease: the use of urethrogram and cystogram in the diagnosis of bladder displacements and deformities in the multiparous woman, results of routine surgery in such cases, treatment of infections in the abnormal bladder.

W. JAMES MYNTER—9 C anatomy

Staff—9 Dry clinic. CARL BEVIER Acute appendicitis beyond the age of fifty. W. JAMES MYNTER Subject to be announced. ARNOLD STARK Effect of diaphragmatic paralysis on the efficiency of cough. JACOB FINE Postoperative distention, an experimental study. LOUIS NABON Gas bacillus infection complicating leprosy. BENJAMIN BARKER Differential diagnosis of pyrexia. I. R. JAKUBSON Indications for ileostomy in ulcerative colitis. CHARLES G. MYNTER Regional ileitis. MACRICK BARKER Is radical resection for carcinoma of the rectum the best procedure?

Thursday

Staff—9 Symposium on total thyroidectomy for chronic heart disease and angina pectoris. HERMAN L. BLUMKART Rationale of total thyroidectomy in chronic heart disease. JOSEPH RICHMAN End-results of total thyroidectomy in angina pectoris. DAVID DAVIS End-results of total thyroidectomy in congestive heart failure. HERMAN L. BLUMKART Indications and contra-indications for surgery selection of cases. CHARLES G. MYNTER General surgical considerations in total thyroidectomy. DAVID D. BERLIN

Technical considerations in total thyroidectomy. DAVID DAVIS The treatment of postoperative complications. DOROTHY GILLMAN Parathyroid insufficiency following total ablation of the thyroid gland. MARK ALTMAN and ALFRED WEINSTEIN Total thyroidectomy moving picture demonstration, demonstration of cases.

CHARLES G. MYNTER, DAVID D. BERLIN and associates—5 Total thyroidectomy.
E. GRANVILLE CHAFFIN and associates—5 Bladder surgery: operative and dry clinic.

Friday

MARK ROGERS and associates—9 Orthopedic dry clinic. Methods and results of manipulation of subdeltoid burrsts: slipping epiphyses, femoral neck club foot, demonstration of application of plaster cast, method of drainage of septic knees, posterior incision, steeking tenosynovitis, operative results, Nicola operation, end results in three cases of recurrent dislocation of the shoulder: marble bones, repeated fracture of the femur, fractures of the long bones in Paget's disease, compression fractures of the spine in diabetes and old age, correction of hallux valgus, temporary paralysis of the artery nerve affecting the joint.
CHARLES G. MYNTER and associates—9 General surgical operations.

Staff—10 30 Dry clinic. WILLIAM DUMMICK Blood changes in surgical conditions. HYMAN MOSKOW Neoplasms stimulating acute surgical disease. HARRY DIXON Significance of postoperative rise in non-protein nitrogen. ARNOLD STARK and S. RICHMAN Metastatic Postoperative renal suppression. CHARLES G. MYNTER Surgery of the large intestine. S. GARFINK and M. FALCOW LESLIE Thyroid clinic experience.
E. GRANVILLE CHAFFIN and associates—5 Renal surgery.

Staff—5 Symposium on tumors. WILLIAM DUMMICK Malignancies of the blood forming organs. HARRY F. FRIEDMAN and LOUIS M. FRIEDMAN Laryngeal carcinoma, diagnosis and treatment, prevention of cases. RICHARD B. DAVENPORT Differential diagnosis of breast tumors. CHARLES G. MYNTER Surgical treatment of breast tumors. HARRY F. FRIEDMAN Radiation treatment of breast tumors. MORRIS J. SCHLESER Oes. The diagnosis of malignancy from anatomic and pleural fluids. HARRY F. FRIEDMAN and LOUIS ALBERT Policy toward married women in regard to carcinoma of the uterine cervix. JACOB H. SCHLESER Diagnosis of carcinoma of the skin. HARRY F. FRIEDMAN Cure of radium treatment of carcinoma of skin. SAMUEL A. ROSENBERG Roentgen diagnosis of renal tumors. E. GRANVILLE CHAFFIN Surgery in renal tumors. GEORGE C. PRATTEN Results of surgery in renal tumors; testicular tumors.

Daily Exhibit in Medical Research Laboratories

WILLIAM DUMMICK Blood changes in surgical conditions. HERMAN L. BLUMKART Total thyroidectomy for chronic heart disease. HARRY A. DIXON Renal function tests in surgery. SAMUEL A. ROSENBERG Demonstration of interesting or unusual X-ray films. MORRIS J. SCHLESER Surgical pathological specimens with case histories.

BEVERLY HOSPITAL

Thursday

PETER JOSEPH and JOHN ADAMS—10 Fracture clinic

PFTER BENT BRIGHAM HOSPITAL

Monday

- DAVID CHEEVER—2 Surgical clinic.
H. F. NEWTON—3 Thoracoplasty
S. A. LEVINE—3 30. Circulatory emergencies in surgical patients

Tuesday

- Staff—9. General surgery operative clinic.
C. C. CUTLER—1. Total thyroidectomy
C. L. DILLON—3 Symptoms and diagnosis of vascular thrombosis
JOHN HOMANS—3 30. Swollen legs.

Wednesday

- Staff—9. General surgery operative clinic.
HENRY A. CHRISTIAN—2 Medical clinic
M. C. SOMMER—3 Recent developments in diagnostic radiology
E. S. EMERY JR.—3 30. Results of surgical procedures for relief of peptic ulcer

Thursday

- Staff—9. General surgery operative clinic.
W. C. QUINBY—2 Indications for and results of total cystectomy
J. C. LICKEL and G. P. GRANFIELD—2 30. Denervated kidney studied by means of the divided bladder
M. S. STROCK—3 Methods of fixation of fractures of the jaw
S. B. WOLBACH—3 30. Demonstration of surgical pathology

Friday

- Staff—9. General surgery operative clinic
DAVID CHEEVER—2. Cancer of the stomach
F. C. NEWTON—3 30. Cancer of the rectum
R. FITZ—3 Function of the spleen
W. P. MURPHY—3 30. Treatment of pernicious anemia, motion picture demonstration
F. R. OBER—3 45. Treatment of neuromuscular sequelae of pernicious anemia.

HARVARD MEDICAL SCHOOL

Monday

- G. KENNETH COONKE and OTTO AUTRANC—2 (Bldg. C)
Demonstration of the mechanical factors controlling the pulmonary circulation
CHARLES L. SCUDDER and associates—2 (Bldg. E) Symposium on fractures

Tuesday

Building D—2

- GEORGE B. WISLOCKI. Studies in mammalian reproduction.
VALY MENKIN. Some problems of inflammation related to surgery
HENRY G. SCHWARTZ. An experimental study of sympathetic reflexes.
J. L. BREMER. The postnatal growth of the mammalian lung
HAROLD L. WEATHERFORD. The finer changes in the liver cells in anaphylactic shock.
LESTER S. KURO. Some aspects of the hemato-encephalic barrier

Building E—2

- G. A. BENNETT and WALTER BAUER. Joint changes resulting from trauma
HUGH K. WARD. Streptococcal infections

- Cecil K. DRINKER. The physiology of the lymphatic system and its bearing on certain problems in surgery

Wednesday
Building C—2

- HALLOWELL DAVIS. Effect of cerebral anemia on the electrical response of the cortex
M. I. GREIDERSEN. The use of hypertonic sucrose solution to reduce cerebrospinal fluid pressure without a secondary rise
WALTER B. CANNON. Some relations of the sympathetic nervous system to surgery

Building B—2

- DAVID CRUTTER. Surgical anatomy of the abdomen demonstrated on cadaver

Building E—2

- FRANK OBER and associates. Orthopedic problems from Children's Hospital. A. H. BREWSTER. Scoliosis. J. KIDDER. Posture and postural scoliosis. P. NORTON. Posterior transplants. H. FITZSIMMONS. Congenital deformities

Thursday

- CHARLES L. SCUDDER and associates—2 (Bldg. E) Symposium on fractures.

Friday

- Symposium on Industrial Surgery—2—Building C
JOHN D. ADAMS and W. A. ROGERS. Injuries of the back.
HENRY MARBLE, F. J. COTTON and J. D. ADAMS. Injuries of the nervous system
F. J. COTTON and J. H. BURNETT. Colles fracture.

Orthopedic Clinic—2—Building E

- W. GREEN. Osteomyelitis in infants and children
R. H. MORRIS. Septic hips with involved heads
A. T. LEON. Osteomyelitis of the tibia
R. JOYLIN. Multiple myeloma
A. H. BREWSTER. Peroneal spasm.
R. H. MORRIS. Knee flexion.

Daily

- WATSON MUSEUM—M. CANAVAN, Curator—2
Demonstration of Dwight collection of spines illustrating deformities, anomalies, diseases. Bone tumors, with X rays, histories, and macroscopic slides, with microscopes available for examination (some of these specimens were used in the illustrations in the monograph on "Bone Sarcoma" issued by the American College of Surgeons). Models showing various types of club feet and effects of operation. Pictures illustrating pathological conditions of bone in Dr. Nichols' collection. Fractures and dislocations of bones as they existed before industrial plants provided so many safeguards. Tuberculous of bones and joints. Syphilis of bones. Dislocation of ends of bones. Collection of old surgical instruments, obstetrical forceps, turnkeys for extracting teeth, urological tools, cupping and leeching instruments.

HARVARD UNIVERSITY

(Dillon Field House, Soldier's Field)
Opposite Harvard Stadium, Allston, Mass.
Wednesday

- AUGUSTUS THORNDIKE JR.—2. Care and prevention of traumatic injuries in athletics. demonstration of protective strapping, padding and apparatus used in modern athletics.

ST. ELIZABETH'S HOSPITAL

Tuesday

- JOSEPH STANTON—9 Subtotal thyroidectomy
 GEORGE KIRKMAN—9 Hysterectomy
 CHARLES KIRKMAN—9 Supravaginal hysterectomy
 E. J. O'BRIEN—9 Transurethral resection of prostate
 E. M. HODGKINS—10 Repair of postincisional hernia with peritoneal fascial strips, by utilizing sac
 JOHN SMILLIE—11 Radical operation for cancer of tongue
 THOMAS BRODERICK—10 Spine fusion
 BENJAMIN BOLAND—11 Low transverse cervical section
 LAURENCE LOOTS—11 Total thyroidectomy
 Staff—3 Dry clinic CHARLES KIRKMAN Series of spontaneous rupture of the uterus. RUSSELL SULLIVAN Ind results of bone and joint problems. LAURENCE LOOTS Postoperative total thyroidectomy for (a) angina pectoris, (b) congestive heart disease. FRANK P. MCCARTHY Frozen sections demonstration and discussion of pathological specimens

Wednesday

- JOSEPH STANTON—9 Hysterectomy
 GEORGE KIRKMAN—9 Cholecystectomy
 RUSSELL SULLIVAN—9 Nicola operation for recurrence of dislocation of shoulder
 LAURENCE LOOTS—9 Radical operation, cancer of breast
 E. J. O'BRIEN—9 Nephrectomy for tuberculous kidney
 WILLIAM McDONALD—9 Operation for correction of childhood injury
 THOMAS BRODERICK—9 Reconstruction of hip joint
 M. G. O'BRIEN—9 Removal of cartilage from knee joint
 EDWARD HOOKER—9 Repair of recurrent inguinal hernia with fascial strips
 MARTIN SPILLER—9 Sacro-tubercular arthrodesis
 Staff—3 Dry clinic WILLIAM DOUGLAS Industrial surgery. JOHN WICKHAM Diseases of the gall bladder. Medical cases either refusing operation or being surgically unfit, demonstration of cases. FRANK JANTZEN Cholecystitis and liver dysfunction (a) with hypothyroid syndrome, (b) with hyperthyroid syndrome. MICHAEL MCCARTHY Hip graft in reconstruction of foot. JOHN CASEY Disease of spleen from a surgical standpoint. THOMAS BRODERICK Demonstration of spinal cases with operative technique. Lantern slides

Thursday

- JOSEPH STANTON—9 Gastro-enterostomy
 BRYANT WETHERILL—9 Nephrectomy
 FRANK JANTZEN—9 Inguinal herniotomy under local anesthesia
 EDWARD HODGKINS—9 Gastro-enterostomy
 THOMAS BRODERICK—9 Reconstruction of hip joint
 CHARLES KIRKMAN—10 Prolapsed uterus with perineal repair and suspension
 WILLIAM DOUGLAS—9 Suprapubic prostatectomy
 EDWARD O'BRIEN—9 Suprapubic cystostomy
 MICHAEL MCCARTHY—11 Fascial repair of double recurrent inguinal hernia
 BENJAMIN BOLAND—11 Tubal plastic for sterility
 Staff—3 Dry clinic WILLIAM O'HALLORAN Medicine from a pre-operative and postoperative standpoint. BRYANT WETHERILL Discussion of diagnosis of carcinoma of bladder. WILLIAM McDONALD Polyneuropathy in pregnancy. JAMES LYNCH Vulval phlebectasis complicating pregnancy. ANTONIA JOSEPH STANTON Hypocholesterolemia of unusual origin, gastric ulcer; demonstration of interesting clinical cases

NEWTON HOSPITAL

Tuesday

- E. D. LEONARD—9 Breast amputation
 G. M. MORRISON—9 Reconstruction of elbow
 G. K. COOMBS—9 Operation for fractured patella
 E. G. CRANFORD—9 Cystostomy
 F. W. MURPHY—9 Pancreatic anesthesia
 D. G. NUTTER—9 15 Dermoid cysts of the abdomen
 R. I. SMITH—9 30 Carcinoma of the duodenum
 G. C. PRATER—9 30 Renal calculus
 N. P. BRACKETT—10 Strangulated hernia in the aged
 D. G. NUTTER—10 Hysterectomy for fibroids
 G. K. COOMBS—10 Triceps repair of olecranon fracture
 G. M. MORRISON—10 Ankle fractures
 F. R. CLARK—10 Cesarean section
 H. WATERS—10 15 Intussusception in infancy
 D. G. NUTTER—10 30 Pyromyoma
 L. D. LEONARD—10 45 Paralytic ileus
 R. I. SMITH—11 Complete thyroidectomy for angina pectoris
 N. P. BRACKETT—11 Cholecystectomy
 H. G. DOWNEY—11 Ligation of saphenous vein for varicose ulcer
 Fracture and orthopedic services—9 Dry clinic Demonstration of application of plaster casts, Boehler technique application of Anderson well leg traction apparatus treatment of fractures of the spine including hyperextension, fractures, jackets, etc.; treatment of Colles fracture by Cotton-Lester method demonstration of new type humeral traction abduction splint
 Staff—3 Symposium on obstetrics. E. GRAYVILLE CLARKE Discussion of urinary tract infection in pregnancy. GEORGE C. PRATER Discussion of loose kidneys in pregnancy. F. R. CLARK, M. F. EADES, and G. C. MAY Pre- and postoperative care of patients
 ROBERT G. VANCE—2 X-rays of traumatic skulls

PALMER MEMORIAL HOSPITAL

Tuesday

- Staff—9 Treatment of malignant disease, including surgery, electro-surgery and radium implantation, operative clinic
 Staff—3 Dry clinic G. A. LEE 40 Carcinoma of cervix. FLETCHER LOUIS Urinary tract complications from carcinoma of the cervix. L. S. MCKITTRICK Interstitial radiation for carcinoma of the breast. R. H. DREBBER Irradiation of the ovary in cancer of the breast. GEORGE O. SMITH Diversion of the urinary stream. JOHN HODGSON Relief of pain in malignant disease

Wednesday

- Staff—9 Treatment of malignant disease including surgery, electro-surgery and radium implantation, operative clinic

Thursday

- Staff—3 Dry clinic D. F. JONES Surgical management of carcinoma of the rectum. L. S. MCKITTRICK Factors favoring early diagnosis of cancer of the colon, principles of treatment. R. H. SMITH Polyps of the colon. BENJAMIN WATERS Pathological aspects of rectal polyps. WILLIAM RICHMOND Blood dyscrasias after gastrectomy and short-circuiting operations on the intestinal tract

Friday

- Staff—9 Treatment of malignant disease, surgery, electro-surgery and radium implantation, operative clinic

NEW ENGLAND DEACONESS HOSPITAL

Tuesday

F H LAHEY H M CLUTE, R B CATTILL, and R H OVERHOLT—9. General surgical operations
GILBERT HORRAX and JAMES POPPEN—9. Neurosurgical operations

RICHARD H. OVERHOLT—9. Thoracic surgery operations
G E HAGGART—9. Orthopedic operations.
JAMES B HICKS—9. Urological operations.
LINCOLN F SISE, PHILIP E. WOODBRIDGE, and URBAN EVERSOLE—9. Anesthesia.

F H LAHEY—9. Esophageal diverticulum, dry clinic.
GILBERT HORRAX—9. Malignant exophthalmos, dry clinic.
Staff—3. Dry clinics H M CLUTE Management of obstructive jaundice, exploration of common duct
GILBERT HORRAX Brain tumors, malignant exophthalmos. SARA M JORDAN Gastric cancer and ulcer gastrojejunal ulcer. F H LAHEY Total gastrectomy for cancer gastrojejunal colic fistula, surgery of intractable ulcer. EVERETT KIEFER Hemorrhage in peptic ulcer. RICHARD B CATTILL Emblectomy parathyroid tetany

Wednesday

F H LAHEY H M CLUTE, R B CATTILL, and R H OVERHOLT—9. General surgical operations
GILBERT HORRAX and JAMES POPPEN—9. Neurosurgical operations

RICHARD H. OVERHOLT—9. Thoracic surgery operations
G E HAGGART—9. Orthopedic operations.
JAMES B HICKS—9. Urological operations
LINCOLN F SISE, PHILIP D WOODBRIDGE, and URBAN EVERSOLE—9. Anesthesia.

Staff—2. Dry clinics. G E HAGGART Subdeltoid burr cuts treatment of flexion deformities. JAMES L POPPEN End-results in trigeminal neuralgia spinal fluid pressure dynamics. FRANK H LAHEY Esophageal diverticulum hyperthyroidism. H M CLUTE End-results in hyperthyroidism. LEWIS M HUNTER Thyrocardiac patients. EVERETT KIEFER Ulcerative colitis. RICHARD B CATTILL Surgical treatment of ulcerative colitis. RICHARD OVERHOLT Limited thoracoplasty in pulmonary tuberculosis cancer of lung

Thursday

E. P JOELIN H F ROOT L S MCKITTERICK, and T C PRATT—9. Surgical and medical diabetic ward rounds.
T C PRATT—10 30. Thigh amputation for diabetic gangrene.

L S MCKITTERICK—10 30. Grift-Stokes amputation for diabetic gangrene.

Staff—2. Dry clinic. Surgery in diabetes mellitus. E P JOELIN Medical care of the surgical patient. L RICKS AND Otolaryngological aspect of diabetes. J H WAITE. Cataract surgery in diabetes mellitus. Gangrene and infection of the lower extremities. H F ROOT. Preventive measures. L S MCKITTERICK Factors influencing the level of amputation. T C PRATT Indications for guillotine amputation. R S TITUS Obstetrics in diabetes. MARK ROGERS Depressed fracture of the spine in diabetes, subdeltoid burr in diabetes mellitus.

Friday

F H LAHEY H M CLUTE, R B CATTILL, and R H OVERHOLT—9. General surgical operations.
GILBERT HORRAX and JAMES POPPEN—9. Neurosurgical operations
RICHARD H OVERHOLT—9. Thoracic surgery operations

G E HAGGART—9. Orthopedic operations.

JAMES B HICKS—9. Urological operations.

LINCOLN F SISE, PHILIP D WOODBRIDGE, and URBAN EVERSOLE—9. Anesthesia.

Staff—2. Dry clinics. R B CATTILL Cancer of the colon and rectum. GILBERT HORRAX Root resection for trigeminal neuralgia cordotomy for pain. JAMES POPPEN Spinal cord tumors. RICHARD OVERHOLT Cancer of the breast. JAMES B HICKS Transurethral resection of the prostate. H M CLUTE Subphrenic abscess. F H LAHEY and FRANK N ALLAN Para thyroid tumors

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

Tuesday

LETTITIA D ADAMS, BLANCHE ATWOOD and GRACE ROCKFORD—9. Surgical operations.

Staff—2. Dry clinics. GRACE ROCKFORD and MARJORIE WOODMAN Dr Alonso Paine's method of delivering posterior positions, motion picture and manikin demonstration. ILIA GALLIANT Carcinoma fundus in a young woman treated for amenorrhea with Antutrin S. ANSTIS MANTON Fibrosarcoma of liver in child of six. FELICIA BARAS Carcinoma of kidney with metastases in child of three. MIRIAM KATZKY Familial muscular dystrophy demonstration of cases and motion pictures. BLANCHE ATWOOD Demonstration of an unusual type of fracture of pelvis with special apparatus used. OLGA C LEARY Unusual pathological specimens with case histories.

Wednesday

LETTITIA D ADAMS, BLANCHE ATWOOD and GRACE ROCKFORD—9. Surgical operations.

MARJORIE WOODMAN, DR. FRIEDMAN, R A. DRAFER DR. GIBSON, E A. POLCARI and M. K. MATARAZZO—9. Obstetrical clinic. Demonstration of analgesia, maternity ward rounds, prenatal clinics, parent-teaching clinics

Thursday

LETTITIA D ADAMS, BLANCHE ATWOOD and GRACE ROCKFORD—9. Surgical operations.

Friday

LETTITIA D ADAMS, BLANCHE ATWOOD and GRACE ROCKFORD—9. Surgical operations.

ROBERT B BRIGHAM HOSPITAL

Monday

L M SPEAR—2. Classification of types of arthritis.

L T SWANN and J KUDOS—3. Treatment and orthopedic principles involved in arthritis

Tuesday

H K THOMPSON—2. Clinical analysis of arthritis with reference to classification and treatment

P D WILSON and S. ROBERTS—3. Discussion of operative procedures, demonstration of end results.

Wednesday

L M SPEAR—2. Classification of types of arthritis

L T SWANN and J KUDOS—3. Treatment and orthopedic principles involved in arthritis

Thursday

H K THOMPSON—2. Clinical analysis of arthritis with reference to classification and treatment.

P D WILSON and S. ROBERTS—3. Discussion of operative procedures, demonstration of end results.

BOSTON DISPENSARY

Tuesday

Tumor clinic staff—*q* Dry clinic FRANK W. MARTIN. Anesthetics in operative cases. CHARLES M. PROCTOR. Precancerous and benign lesions of the oral cavity. CHARLES E. DUMAS. Radium technique in malignancy of the throat. LEONARD A. SCHALL. Treatment of cancer of tonsil. GEORGE S. SPARE. Malignant degeneration of sebaceous cysts. LOUIS F. FRANCIS. Precancerous lesions and cancer of the cervix, lantern slide demonstration. ALICE E. EITZINGER. Early diagnosis of malignancy of gastro-intestinal tract by relief method. HAROLD A. CH. MERRILL. Papillary tumors of the kidney pelvis. RUTH C. GRAVES. Management of cancer of penis with particular reference to a modified operation for advanced cases. MYRON J. HARR. Cancer of the prostatic capsule. LEONARD OLIVER. Management of malignancy of the lymphatic system. HENRI J. DAY. Cancer of breast, end results of dispensary and personal cases. JOSEPH ROSENBERG. Bleeding carcinoma of breast without tumor. WILLIAM M. SHERMAN. Management of cancer of rectum with particular reference to irradiation. HENRI J. DAY. Relation of pathology department to tumor clinic.

Wednesday

Staff—*q* Dry clinic OLIVER C. TENNANT. Clinical teachings of third-year medical students. FRANCIS P. BARLOW. Use of adhesive plaster. P. A. COVATTA. Adenomatous changes in subacute thyroid. HENRI J. DAY. Management of a cancerous vein clinic, where over 150 treatments a week are given. EDWARD T. WHITNEY. Varicose ulcers, demonstration of cases and treatment. WALTER L. LEVISON. High location of aneurysms. WILLIAM M. SHERMAN. Injection treatment of neuritis. S. S. SHERMAN. Results of multiple injections of aneurysms at same site. HENRI J. DAY. Results of excision of aortic aneurysm following injection treatment.

Thursday

Staff—*q* Dry clinic JOSEPH D. ADAMS. Shoeffler-Christian disease (xanthomatous), bone tumors. ROY E. M. SMITH. Chondroma and chondrosarcoma. WILLIAM A. HENRY. Detection of syphilis as an aid in practice of surgery. FRANCIS M. THURMON. Syphilis and the differential diagnosis of surgical conditions. JOSEPH SHERBELL. Ophthalmic studies in syphilis. GRACE E. ROCHFORT. An unusual gynecological condition. LOUIS A. O'CONNOR. Pain in the shoulder girdle. ROBERT W. BLICK. Kidney function renal function tests. WILLIAM E. DAVIS. Some observations on treatment of peptic ulcer in out-patient clinic. ALICE EITZINGER. Diagnosis of activity of duodenal ulcer by X-ray. KATHERINE S. ANDERSON. Hiatus hernias. HENRI J. DAY. Solitary gall stone pain relieved by posture. Demonstration of interesting X-ray plates of peptic ulcer and gall-bladder disease.

WALTHAM HOSPITAL

Friday

R. L. DENORMANDE, T. W. HARRIS, D. MUNRO, J. D. BARNETT, J. W. SILVER, H. Q. GALLUPP, R. COLLINS, and H. A. WOOD—*o* Surgical operations.
R. L. DENORMANDE, T. W. HARRIS, D. MUNRO, J. D. BARNETT, J. W. SILVER, H. Q. GALLUPP, R. COLLINS, and H. A. WOOD—*s* Dry clinics. General surgery, orthopedics, obstetrics, pathology, etc.

FREE HOSPITAL FOR WOMEN

Tuesday

F. A. PEMBERTON, G. V. SMITH, and S. C. GRAVES—*q* Operative and dry clinic. Carcinoma of cervix uteri, treatment and results, prevention, diagnosis of early cases, relation to cervicitis and its treatment, complications of radium treatment, relief of pain carcinoma of fundus uteri, treatment and results, classification of other tumors of uterus—fibroids, adenomyoma.

Wednesday

F. A. PEMBERTON, G. V. SMITH, and PAUL LOUGHE—*q* Operative and dry clinic. Tumors of the ovary, diagnosis, treatment and results. Cystadenoma, granulosa cell tumor. Brenner tumor, teratoma, endometriosis, diagnosis and treatment. Tumors of tubes, round ligaments, and vagina.

Thursday

G. V. SMITH and JOHN ROCK—*q* Operative and dry clinic. Sterility, diagnosis, treatment and results, menorrhagia and metrorrhagia, diagnosis, treatment and results. Endocrine research, dysmenorrhea.

Friday

F. A. PEMBERTON, E. B. SUTHERLAND, and S. C. GRAVES—*q* Operative and dry clinic. Prolapsed prolapsing, complete tear of perineum, vesico- and rectoanal fistula, fistulotomy of a carcinoma valve. Trichomonas vaginalis, tumors of breast, value of X-ray treatment.

PONDVILLE STATE CANCER HOSPITAL

Tuesday—*s*

EDWARD M. DALAND. The Massachusetts cancer program. HENRY JACKSON, JR. Some aspects of malignant lymphoma. JOE V. MINTO. Ovarian tumors. LUCIEN F. MASON. Treatment of cancer of the cervix by X-ray followed by radium. ROGER GRAVES. Cancer of the prostate with metastases. CHARLES KIRCHMAN. Cancer of the penis. CHARLES DUNN. X-ray treatment of advanced skin cancer, demonstration of cases.

Friday—*s*

GRAUNTLEY TAYLOR. Radium needles in cancer of breast. HOWARD ROGERS. Chronic cystic mastitis. RICHARD DRENNER. X-ray in the diagnosis of gastro-intestinal cancer. SHELLEY WARREN. Changes in tumor tissue caused by radiation. JOHN HENDERSON. Treatment of pain in cancer patients. CARL EDWARDS. Cancer of the atrium, demonstration of cases.

INDUSTRIAL SURGERY

Tuesday

H. C. MARBLE and H. P. TORRE (142 Berkeley Street)—*q*
D. LYNN and B. GOVITT (245 State Street)—*q*

Wednesday

G. W. MORSE (3 St. James Avenue)—*q*

Thursday

WILLIAM DOLAN (110 Milk Street)—*q*

Friday

J. H. SHORTELL (760 Tremont Street)—*q*
D. LYNN and B. GOVITT (245 State Street)—*q*

FAULKNER HOSPITAL

Wednesday

- F J COTTON, E. G. BRACKETT and associates—9. Bone and joint clinic, operative and dry
 Staff—1. Dry clinic. E. G. BRACKETT Hip fracture
 F J COTTON Bone tumors fractures of pelvis
 C. MARBLE Hand surgery: fractures of the fore arm. J D ADAMS Industrial lesions of the knee
 WILLIAM A. ROGERS Compression fracture of spine.
 E. A. COOMAN Shoulder lesions B. GOVIX Olecranon fractures. W F COTTON Ankle fractures
 H. E. SOWLES Elbow fractures Demonstration of X-ray plates and pathological specimens

Thursday

- E. L. YOUNG JR., R. C. COCHRANE, A. R. KIMPTON and associates—9. Operative clinic
 J. R. TORBERT and R. S. TITUS—11. Obstetrical clinic
 S. W. WOODS—11. Postoperative pulmonary complications.
 Staff—8. Symposium on pre-operative immunization of the peritoneal cavity. H. L. JOHNSON Theoretical and experimental evidence of the benefit of amfetin.
 E. L. YOUNG JR. and EVERETT O'NEIL Clinical evidence of immunity from amfetin injection. R. C. COCHRANE and BURTON HAMILTON Total thyroidectomy for heart disease. F. G. BAUER, JR. Injection treatment of hemorrhoids.

COLLIS P. HUNTINGTON MEMORIAL HOSPITAL

Monday

- Staff—8:15. Tumors and diseases of bones, dry clinic
 J. C. AUST Calcium metabolism in diseases of the bones. CHANGING C. SIMMONS Malignant tumors of bone. RICHARD DREXLER Radiological diagnosis of bone tumors and certain rare forms of skeletal diseases.
 C. C. FRANKLIN The phosphatase content of the blood in bone tumors and skeletal diseases.
 GEORGE A. LELAND and J. V. MEIGS—3:30. Carcinoma of the cervix

Friday

- Staff—3:15. Carcinoma of the oral mucous membrane, dry clinic. CHANGING C. SIMMONS Choice of treatment in the individual case. C. C. LUND Results of treatment of cancer of lip. GRANTLEY W. TAYLOR Carcinoma of the mouth in the female. RICHARD DREXLER Radiation treatment of oral carcinoma. CHARLES B. HOPKINS Prophylaxis of cancer of the mouth. SOMMER STURGIS Electrical currents between fillings of different metals as an etiological factor in leukoplakia and carcinoma of the mouth
 E. W. HERMAN and LEROY A. SCHALL—3:30. Carcinoma of the accessory sinuses, tonsils, and larynx

STATE PRISON COLONY

Day to be announced

- HILBERT DAY Practice of medicine in a modern correctional institution
 WILLIAM BLOOMBERG. Psychiatric approach to prison medicine
 HENRY R. CRAIG Unusual incidence of peptic ulcer in a prison population.
 GEORGE H. LYONS Minor surgical injuries in a protected population.
 GEORGE ROTTERBLATT Dental conditions causing personality changes.

CAMBRIDGE HOSPITAL

Tuesday

- Staff—9. General surgical operations.
 Staff—9. Dry clinic. A. W. DUDLEY Subject to be announced. H. F. DAY E. H. McMAHON and H. P. STEVENS Lipoid degeneration of uterus. SOMMER FRAZER Subject to be announced. DAVID ROSE Subject to be announced. C. T. O'CONNOR Cesarean section. H. L. SEVER Delivery of a living child from dead mother. E. H. McMAHON Pathological subject to be announced. T. H. LAXMAN P. J. MAHONEY and J. W. NICHOLS Subject to be announced. W. STEWART WHITTEMORE Subject to be announced.
 Staff—1. Dry clinic. A. H. CROSSIE and H. A. CHAMBERLAIN Horseshoe kidney. H. F. DAY Effect of posture on the solitary gallstone. S. S. HARTIG Otitompylitis. STANLEY NOWAK Subject to be announced. OSCAR RAEDER Subject to be announced. H. P. STEVENS Analysis of cases of biliary surgery

NEW ENGLAND BAPTIST HOSPITAL

Tuesday

- HAILEY B. LODGE—9. Operative clinic
 Staff—9. Dry clinic. HAILEY B. LODGE Portal thrombosis, ulcerative colitis, gall stones, pancreatitis, uterine fibroids. A. A. HORNOR Ulcerative colitis. ROBERT L. DENORMANDE and DELOS J. BRISTOL Blood transfusion in obstetrical management of borderline obstetrical cases. anaesthesia and analgesia in obstetrics prevention of eclampsia

Thursday

- F. H. LAHEY, H. M. CLUTE, R. B. CATTELL, and R. H. OVERHOLT—9. General surgery operative clinic.
 GILBERT HORRAX and JAMES PORFIM—9. Neurosurgical operations.
 G. E. HAAGART—9. Orthopedic surgery
 JAMES B. HICKS—9. Urological surgery
 LINCOLN F. SISE, PHILIP D. WOODBRIDGE, and URBAN EVERSOLE—9. Anesthesia.

BOSTON LYING-IN HOSPITAL

Tuesday and Thursday

- FREDERICK C. IRLING and associates—9. Obstetrical operations: demonstrations of premature nursery, X-ray department, research laboratories, and hospital ward.
 FREDERICK C. IRLING and associates—3. Dry clinic Fetal roentgenometry; anemia in pregnancy; treatment of heart disease in pregnancy; treatment of diabetes in pregnancy; management of neglected cases of cephalopelvic disproportion; treatment of placenta previa; separation of the symphysial pubis; kidney function tests in pregnancy; classification of the albuminuric and hypertensive conditions in pregnancy factors which make for viability in premature infants erythroblastosis fetalis barbiturates and other analgesic drugs in labor

SYMMES ARLINGTON HOSPITAL

Tuesday

- F. J. COTTON—9. Bone and joint surgery
 A. L. BRETT—9. Tumor of the spinal cord shockley arthrodesis
 G. P. TOWLE—9. General surgery
 S. G. JONES—9. Volkmann's paralysis.

EVANGELINE BOOTH MATERNITY HOSPITAL

Wednesday

A K PAINE, H S FINELL, W J M DONALD, M G BRYLEY, J HOPKINS, D GOLDFARB, A A LEVI, J J CORRY, H BAKER, S OSGOOD, and R T PHILLIPS
—g Gynecological operations and obstetrical procedures.

Staff—s A review by demonstration, charts, pictures, and exhibits, of the obstetrical experience of the Booth Hospital. Maternal mortality factors responsible for the declining rate at the Booth Hospital: the bleeding cases, statistics, management and results, obstetrical sepsis, anemia, analgesia, and anesthesia in labor, results from the standpoint of safety, efficiency, effects on operative incidence, cesarean section, incidence, indications, and mortality, uterine of pregnancy, treatment, methods and results over a fourteen year period, "debunking" pelvimetry, heart disease complicated by pregnancy, fetal mortality, analysis of four hundred cases, pathology.

MASSACHUSETTS WOMEN'S HOSPITAL

Thursday

HENRY T HITCHCOCK—g Perihysterectomy
STEWART ROSENBERG—g Plastic laparotomy
WILLIAM A WELBY, Jr—g Laparotomy
REGINALD MURPHY—g Transverse cervical cesarean section

ROBERT L MCKAY—g Thyroidectomy
Staff—s Dry clinic. CHARLES H LAWRENCE. Endocrine sterility and results. DONALD MACOSHER. Problems of sterility. CHARLES F FINELL. Congenital obturator dislocation of right hip, causes of elongation of bone. J STEWART ROONEY. Pathological specimens.

LAKEVILLE SANATORIUM

Wednesday

Z B ADAMS—g 30 Analysis of hip, operative. Ward rounds.

Staff—s Dry clinic. Tuberculous of lymph nodes, genitourinary tract, or gastro intestinal tract, peritoneum and skin.

Z B ADAMS. Orthopedic dry clinic.

MALDEN HOSPITAL

Wednesday

L E PRAXEY and N A GALLAGHER—g Gynecological operations.

R SULLIVAN—g Orthopedic clinic.

L W MCQUEEN—g Amoebic dysentery and its complications.

C F LYNN, D J DUGAN, I J WALKER, and F W GAY—s Surgical operations.

Staff—s Dry clinic. J S ROONEY. Pathological demonstration. I J WALKER. Discussion of jaundice with demonstration of liver specimens. L SOLA. Discussion of coronary and gall-bladder disease in middle-aged people with electrocardiographic tracings. C H STAPLES. Hyperparathyroidism, demonstration of cases.

CHELSEA MEMORIAL HOSPITAL

Thursday

Staff—g Dry clinic. CHARLES P SKELDON. Septic abortions. LUCYWEILLAN H ROCKWELL. Perforated duodenal ulcer. GEORGE A MARAS. Acute appendicitis with peritonitis. STEPHEN B KELLEY. Causes of death in prostaticitis.

Staff—s General surgical operations.

Staff—s Dry clinic. GORDON MONROE. Abdominal trauma. STEPHEN G JONES. Volkmann's contracture. ALFREDER P ARTHUR. Epiphyseal separation of the radius. JAMES S HODGSON. Fractures of the skull. Discussion by IRENEARCA J COTTON.

LONG ISLAND HOSPITAL

Wednesday

R H MORRIS and T H PETERSON—g Fracture clinic. Fracture of the neck of the femur in elderly people. demonstration of Scottler traction apparatus.

H R VICTOR—g Neurosurgical diagnosis.

J H CROFTHAM and C S SWAN—g Urological operations.

A S MACMILLAN—s X-ray demonstration.

I B ALEXANDER—s Pathological demonstration.

C L SWAN, R I SMITH, and T C PRATT—s General surgical operations.

SURGERY OF THE EAR NOSE AND THROAT

MONDAY

H. DAVIS, H. A. DERBYSHIRE and M. H. LURIE—Harvard Medical School, Bldg. C—3 Physiological experiments on the hearing of animals with the technique first reported by Waver and Bray; report of the pathological conditions found in animals with abnormal hearing demonstrating technique and apparatus used physiological experiment conducted on animal with the apparatus used, demonstrating (1) auditory response obtained from the cochlea itself (2) auditory response from the cochlear nerve and its various ganglion centers in the midbrain (3) auditory response as obtained from the cortex of the animal in the temporal lobe (4) the effect of anesthetics on these electrical responses (5) demonstration of masking of tones in the cochlea

TUESDAY

Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases.

WALTER B. HOOVER—New England Deaconess Hospital—9 Osteoma of sinuses, laryngeal and tracheal complications of thyroid surgery—lingual tonsils and lateral bands of pharyngeal lymphoid tissue syndrome of anemia, glossitis, and dysphasia.

JOSEPH W. ROCKETT and THOMAS E. DINAM—Cambridge City Hospital—9 Tomiectomy with gas-oxygen anesthesia presentation of cases of lateral sinus thrombosis

F. G. MINSTER and associates—Carney Hospital—9 Operation and demonstration of cases.

WILLIAM T. HALEY—St. Elizabeth's Hospital—11 Operation for correction of dislocation of nasal septum

H. P. MOSHER—Harvard Medical School, Bldg. B—3 Exhibition of anatomical cases demonstrating the anatomy of the nose and throat discussion of teaching methods demonstration on the cadaver of the submaxillary approach for deep pus in the neck. P. E. MELTZER and M. H. LURIE Exhibition of specimens illustrating the anatomy of the ear

Staff—Beth Israel Hospital—2 L. M. FREEDMAN Experiences with vocal cord paralysis in thyroidectomy JACOB FINE Technique for relief of bilateral recurrent nerve injury CHARLES GETTES Demonstration of technique for eliciting vestibular reactions by galvanism L. M. FREEDMAN Jugular puncture in mastoiditis S. CLINE Tuberculous laryngitis and its treatment S. GARLAND Treatment of malignant tumors of the upper respiratory tract. L. M. FREEDMAN Bronchoscopic studies.

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room Demonstration of historical instruments.

WEDNESDAY

Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases.

WALTER B. HOOVER—New England Deaconess Hospital—9 Operations.

F. G. MINSTER and associates—Carney Hospital—9 Operations and demonstration of cases.

Staff—Children's Hospital—9 LYMAN RICHARDS Acute laryngotracheobronchitis. MAURICE EVANS Bilateral jugular ligation and its neurological complications PHILIP MYTEL Cerebral abscess CHESTER MILLS Sinusitis. JOSIAH E. QUINCY Radical mastoid opera-

tion CHARLES ALLMAN Unusual foreign bodies. FIVEGRILLSPIE Complications in simple mastoidectomy SAMUEL CLINE Cases of sinus thrombosis.

HARRIS J. IN LIA and associates—Boston Dispensary—9 Dry clinic LECTUS WOLFSON Bronchoscopy in the up-lit position as an outpatient procedure. A. I. CLEVEN F. S. DUBRAN and FRANCIS STREAN An improved method of skin testing in allergic disturbances of the ear and throat

JOHN BURNS—St. Elizabeth's Hospital—11 Radical sinus operation and nerve block.

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room Demonstration of historical instruments.

THURSDAY

Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases.

WALTER B. HOOVER—New England Baptist Hospital—9 Operations.

F. J. BUTLER and C. H. ALLMAN—Cambridge Hospital—9 Operative and dry clinic. Hematogenous infection of left mastoid with extradural abscess in a nine months old child pneumococcus type III meningitis with labyrinthitis, demonstration of case.

F. G. MINSTER and associates—Carney Hospital—9 Operations and demonstration of cases.

C. FULCER—Franklin Hospital—11 Operations and demonstration of cases.

WILLIAM T. HALEY—St. Elizabeth's Hospital—11 Radical operation for maxillary antrum.

JOHN BURNS—St. Elizabeth's Hospital—11 Radical mastoid operation.

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room Demonstration of historical instruments.

FRIDAY

Staff—Massachusetts Eye and Ear Infirmary—9 Operations and demonstration of cases.

WALTER B. HOOVER—New England Deaconess Hospital—9 Operations.

F. G. MINSTER and associates—Carney Hospital—9 Operations and demonstration of cases.

Staff—Massachusetts Eye and Ear Infirmary—9. Dry clinic. H. P. CARRILL The present status of brain abscess from the standpoint of the otologist. P. E. MELTZER A twelve year summary of cases of lateral sinus thrombosis at the Infirmary. P. MYTEL A ten year review of cases of labyrinthitis at the Infirmary. D. C. SMYTH Chest cases requiring bronchoscopy, lantern slide demonstration. A. S. MACMILLAN and D. C. SMYTH The accessory sinuses from the standpoint of the roentgenologist and the clinician. A. S. MACMILLAN Petrositis from the X-ray standpoint. G. H. FORKNER Result of the Mosher Toit tear sac operation. M. H. LURIE Histological slides showing the pathological condition of the internal ear. E. W. HERMAN Radium and X-ray treatment of cancer of the larynx. HARRIS P. MOSHER Notes on esophageal cases. F. F. GARLAND Surgery of the submaxillary gland. C. G. PAGE Fungal in tracheal and bronchial mucosa. GEORGE L. TOBEY JR The Tobey Ayrer test.

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room Demonstration of historical instruments.

Days to be announced

- ISABELLA D. KERR—New England Hospital for Women and Children. Avertin anesthesia in tonsillectomies
 MARGARET NOTES KLEINERT—New England Hospital for Women and Children. Mastoidectomies in infants
 CHARLES I. JOHNSON, DONALD H. MACDONALD and EDGAR M. HOLMES—Newton Hospital. Operations and demonstration of cases
 L. F. JOHNSON—Massachusetts Memorial Hospital. Bronchoscopic operative clinic

- C. W. BUSH, R. O. PARRIS, and H. N. WERT—Massachusetts Memorial Hospital. Operations
 H. L. BABCOCK—Massachusetts Memorial Hospital. Otolaryngeal problems in contagious diseases
 A. W. ROWE and D. W. DUNN—Massachusetts Memorial Hospital. Endocrine factors in deafness
 OLIVER A. LUTWIDGE—Newton Hospital. Tonsil, sinus and septum operations, reduction of recent fractures of the maxilar and nasal bones, discussion of the indications for mastoid and sinus surgery

SURGERY OF THE EYE

MONDAY

- Staff—Massachusetts Eye and Ear Infirmary—3 Operations
 V. G. CARTER—Massachusetts Eye and Ear Infirmary—3 Visual fields in neurological cases
 T. L. TERRY—Massachusetts Eye and Ear Infirmary—3 Pathological demonstration
 J. H. WAITT and W. B. CASTLE—New England Dispensary Hospital—3 The eye in diabetes
 W. B. CASTLE—Long Island Hospital—3 The photometer

TUESDAY

- H. B. C. REYNOLDS and assistant—Massachusetts Eye and Ear Infirmary—1 Operations
 A. J. BROWN—Massachusetts Eye and Ear Infirmary—9 Technique in photographing the fundus
 J. W. WHELAN—Massachusetts Eye and Ear Infirmary—9 Plastic operation
 HENRY M. DUNN, WILLIAM D. ROWLAND and JOSEPH J. SKIRBALL—Massachusetts Memorial Hospital—9 Operations
 J. S. FRIDENWALD—Massachusetts Eye and Ear Infirmary—9 Slit-lamp ophthalmoscopy
 PETER M. ADAMS—St. Elizabeth's Hospital—11 Operations

WEDNESDAY

- J. H. WAITT and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
 A. J. BROWN—Massachusetts Eye and Ear Infirmary—9 Technique of photographing the fundus
 F. H. VANDERBILT and assistant—Massachusetts Eye and Ear Infirmary Howe Laboratory—9 Operations and demonstration of cases
 Staff—Carney Hospital—9 Operations
 Staff—Boston Dispensary—9 The eye and syphilis
 HUGH DONAHUE—St. Elizabeth's Hospital—11 Operations for cataract

- ALLEN GREENWOOD—Massachusetts Eye and Ear Infirmary—3 Fundus cases
 T. L. TERRY—Massachusetts Eye and Ear Infirmary—3 Contact glasses
 Staff—Massachusetts Eye and Ear Infirmary—3 Motion picture demonstration of operations
 J. J. REIDAN, SOWA WERT, and DONALD MIFKIN—Boston City Hospital—3 The eye in arteriosclerosis
 V. G. CARTER—Long Island Hospital—3 Operative and dry clinic

THURSDAY

- L. A. ELLIS and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
 H. B. C. REYNOLDS—Massachusetts Eye and Ear Infirmary—9 External diseases of the eye
 C. N. SPATT and others—Massachusetts Eye and Ear Infirmary—9 Motion pictures of operations
 WILLIAM LUDMAN and BENJAMIN SAGRE—Beth Israel Hospital—10 Cataract extraction, muscle advancement, demonstration of cases
 HENRY M. DUNN, WILLIAM D. ROWLAND and JOSEPH J. SKIRBALL—Massachusetts Memorial Hospital—3 Dry clinic

FRIDAY

- W. H. LOWELL and assistant—Massachusetts Eye and Ear Infirmary—9 Operations
 DAVID MCCARTHY—Massachusetts Eye and Ear Infirmary Howe Laboratory—9 Color vision testing
 J. J. REIDAN—Boston City Hospital—9 Operations
 V. G. CARTER—Massachusetts Eye and Ear Infirmary—3 Neurological cases, ocular paralysis
 T. L. TERRY—Massachusetts Eye and Ear Infirmary—3 Pathological demonstration
 E. B. DUNN—Massachusetts Eye and Ear Infirmary—3 Traumatic cases, operations and results
 J. J. REIDAN and W. B. CASTLE—Boston City Hospital—3 The eye in anemic patients

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ANATOMICAL AND EXPERIMENTAL OBSERVATIONS ON AIR EMBOLISM¹

W. H. CHASE, M.D. MONTREAL, CANADA

AIR emboli as a complication of thoracic operations are probably more frequent than is generally recognized. In fact, Reyer and Kohl believe that many of those cases reported as pleural shock are, in reality mild cases of cerebral embolism as the signs and symptoms in both conditions are very similar. In spite of this apparent frequency it is unusual to have the opportunity of making a careful anatomical study of a clear cut, marked instance of air embolism followed by sudden death. For this reason, and because of associated intracranial vascular lesions the following case is recorded. It led to an attempt to obtain a visual conception of living events in air embolism. Consequently measured quantities of room air were injected into the aortic arch in a series of rabbits, while the vascular bed of the duodenal mesenteric loop was observed microscopically *in vivo*.

This was accomplished by using the ingenious apparatus devised by Ricker (10) and his co-workers, which permits the examination of tissues bathed in Ringer's fluid at a constant temperature so that nearly physiological conditions prevail at the start. These experiments indicated that air emboli represent moderate or strong vascular irritants which produce a series of effects which are in all respects similar to those produced by other mechanical, chemical or bacterial irritants, as

described by Ricker (11). Koch and Nordmann (4), A. Dietrich (1) and others. The similarity of the exudative vascular lesions in the histological preparations of these experimental animals, to those of the intracranial vessels in the autopsied case, suggests that a similar neurovascular mechanism is concerned. These experiments are recorded therefore in conjunction with this case report because they seem to emphasize the importance of a neurovascular mechanism which is concerned in lesions associated with diffuse air embolism.

I. CLINICAL ANATOMICAL SECTION

Summary of case record. The patient was a male aged 35 years. For 8 years following a right lobar pneumonia he had repeated attacks of bronchitis. About February, 1931, he developed a typical right sided pleurisy. During the next 6 months he had several recurrences and by October a lipiodol injection showed a diffuse bronchiectasis throughout the right lower lobe with pleural effusion. A right phrenicotomy was done in February, 1932 and a month later the lower lobe was partly resected. Following this partial lobectomy, he had a slow, gradual convalescence due to a bronchocutaneous fistula with empyema. By March, 1933 he had almost regained his normal weight, but lipiodol injections showed an extension of the hypertrophic bronchiectasis throughout middle lobe and remainder of the lower lobe. He continued to have abundant foul sputum. It was decided to do a right middle lobectomy. During the dissection of the lung from the very adherent pleura the main pulmonary vein was inadvertently cut. There was a brisk sharp

¹From The Pathological Institute, McGill University Montreal. Professor Henri Oertel, Director.



Fig 1. Roentgenogram of skull taken 8 minutes after death. Not the pale line linear network which is indicative of air in meningeal vessels, and in region of carotid arteries.



Fig 2. Photograph of diffuse bilateral subarachnoid hemorrhage. The section removed from right parietal cortex shows a gross hemorrhage entirely confined to meninges.

hemorrhage accompanied by a whistling inspiratory sound. It took about 15 seconds before the Kocher clamp could be applied to this bleeder. Within a minute the anesthetist reported that the pulse had fallen to 40 and blood pressure had risen to 160 systolic. Within 3 minutes of this hemorrhage the patient was declared dead.

X-ray pictures of the skull and chest were taken at once. The latter showed no evidence of air in the heart or any of the thoracic vessels. Stereoscopic pictures of the skull, however, showed shadows resembling air outlining the anterior portion of the circle of Willis and extending along the course of the middle cerebral arteries. The air in smaller meningeal vessels appeared as an irregular network of fine pale lines which were most definite over the parietal and temporal areas (Fig. 1).

Synopsis of autopsy findings: 5 hours postmortem. The body was of athletic habitus, and moderately well nourished. There was a recent curved gaping incision from the upper vertebral angle of the right scapula extending downward and forward to the anterior axillary line at the level of the seventh rib. Segments of the fifth and sixth ribs each about 3 centimeters long had been recently removed posteriorly, exposing the pleural cavity which was covered with firm grey tags resembling recently torn adhesions and fluid blood.

The lower half of the lower right lobe of the lung was firmly adherent to the medial half of the diaphragm, while the upper half of this lobe had been removed leaving a stump from which several open bronchi projected. Just below the large lower bronchus, was exposed the main pulmonary vein in which was a linear transverse slit 5 millimeters long. A probe was readily passed through this clean cut opening into the left auricle of the heart.

The heart weighed only 270 grams. The right side contained a small amount of coagulated and fluid blood, while the left was collapsed and contained a small amount of bright red finely frothy fluid blood and a few pale red, irregular semi-solid masses of coagulum. The coronary arteries contained short and long columns of air separated by fluid blood, and there was slight bulging of smaller arterial segments in which the air was located.

The intracranial contents were examined before the thoracic or abdominal cavities had been opened so that the presence of air in these vessels could not be attributed to a replacement of lost blood from any proximally cut vessels. On removal of the calvarium and reflection of the dura mater special care was taken not to cut the leptomeninges or brain substance. All emissary veins in the subdural space were ligated before being cut. Lying in the subarachnoid space over the frontal and parietal convolutions on both sides and extending out from the longitudinal fissure were diffuse areas of dark red fluid blood (Fig. 2). The arteries between the cortical convolutions in the leptomeninges of both frontal and parietal areas contained long and short dilated columns of air between which was fluid blood. Similar air columns and fluid blood filled the arteries of the circle of Willis and extended most ly throughout the anterior and middle cerebral branches. No air could be seen in the very engorged meningeal veins or venous sinuses.



Fig. 3. Right frontal meninges and cortex. Note the red cells which are lying free in the subarachnoid space and which are surrounding the penetrating cortical vessels. Also note a dilated meningeal vein filled with blood. $\times 35$



Fig. 4. Right frontal cerebral cortex. Serum fills and surrounds a vein in upper field and red cells surround a vein in lower field. Between these is a large oval space surrounded and partly filled by red cells. Fragments of a vessel wall are also in this space. $\times 40$

The brain was suspended in 10 per cent formalin for 5 days and then sectioned transversely in thicknesses of 1.5 to 2 centimeters. These sections showed a few small petechial perivascular bloody foci in the cortical gray matter of both frontal and parietal convolutions and the vessels were everywhere very engorged with blood.

Microscopic findings. In general, the histological examination of various organs confirmed the gross findings and will not be described in detail. The vascular changes in many histological sections from various parts of the brain and meninges were examined in the ordinary hematoxylin eosin preparations and also in large frozen sections of nearly half the cerebral hemisphere (Christeller method). These large sections were stained by the Van Gieson technique in order to avoid the shrinkage associated with dehydration. The following noteworthy vascular changes were recorded: (a) Large and small meningeal veins were markedly dilated and filled with well preserved red blood cells and very few leucocytes. (b) The red blood cells also lay in the subarachnoid space and in many places extended around engorged penetrating small vessels in the cerebral cortex (Fig. 3). (c) Many small cortical arteries and capillaries contained serum and red cells while others were collapsed. Well preserved red cells completely surrounded some compressed small veins, and where these perivascular red cells were most extensive the central vessel had partly disintegrated (Fig. 4). In none of the brain sections examined did the perivascular red cells surround arteries.

Anatomical summary. Intracranial and coronary arterial air embolism following incision into the right pulmonary vein during middle lobectomy. Subarachnoid bilateral hemorrhage both frontal and parietal. Petechial perivascular cerebral venous hemorrhage with marked passive hyperemia. Exudative productive pleurisy of the right side. Hypertrophic bronchiectasis of the right middle lobe and of the upper half of the lower lobe with an old partial lobectomy and persistent bronchocutaneous fistula.

II EXPERIMENTAL SECTION

A. Technique. In order to obtain more definite knowledge of the vascular mechanism of air embolism a technique was adopted which permitted a magnification up to 350 diameters of the rabbit's mesentery while air was being injected into the systemic arterial system. This modification of the Ricker apparatus by Loeffler and Nordmann was particularly applicable in these experiments for at least two reasons: (1) the microscopic vascular changes could be followed throughout the air injections *in vivo*, (2) with practice the operator could perfect a technique that permitted him to start with a vascular mesenteric bed that was almost a physiological preparation.

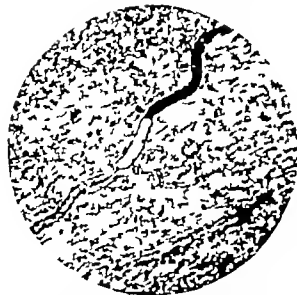


Fig. 5 Arteriole in duodenal loop of rabbit's mesentery. Note the conglomerated mass of red cells behind the dilated segment containing the air embolus. $\times 335$

Air was injected into some part of the aortic arch through a long glass cannula which was inserted into an opening in the lower end of the right carotid artery just over the sternum. Particular care was taken to dissect off the vagus nerve and its depressor fibers from the carotid sheath without undue trauma. The best results were obtained when the cannula was inserted into the descending part of the aortic arch. Apparently because of the greater fixation of the clavicle and sternum in larger rabbits, this favorable position was obtainable only when the animal weighed not more than 1500 grams. To insure this position it was necessary to insert the cannula backward and to the left without undue manipulation.

In order to prevent air reaching the intracranial vessels and causing very rapid death it was also necessary to ligate the left common carotid artery having first dissected it away from the vagus nerve and its depressor fibers. When the cannula could be inserted into the descending aorta, however, it was found unnecessary to ligate the left carotid because it was closed mechanically by the position of the cannula.

A series of 12 rabbits were slowly injected,

at irregular intervals, with measured quantities of room air which entered some portion of the aortic arch while microscopic vascular changes in the duodenal mesenteric loop were carefully recorded. At death the duodenal loop and its attached mesentery were at once removed and fixed for 2 hours in Boulin's fluid. It was then transferred to 10 per cent neutral formalin for at least 6 hours. The larger vessels were then carefully cut away and the mesenteric fragments stained in aceto-carmin for 8 to 10 minutes. (The aceto-carmin is prepared by saturating a boiling 45 per cent solution of acetic acid with carmin and filtering when cool.) The tissue was then mounted moist in Farrant's or Apathy's fluid. In this way it was possible to study in further detail the histological sections of the same mesenteric areas that had already been examined *in vivo*. There were found to be two advantages to this fixation and staining technique: (1) It involved a minimum of shrinkage because the tissue was not dehydrated; (2) The picric acid accentuated cell outlines, while the aceto-carmin stained nuclear structures and red blood cells with a very fine definition.

B Observations. Our observations may be conveniently grouped into (a) those which were common to all the series, and (b) those which applied only to a few or to individual experiments. Three important features must be described in further detail.

1. *Distribution and fate of air emboli.* In no instance did the room air reach further than the mesenteric arterioles. Capillaries and venules were permanently free of air. It tended to remain in long columns in the muscular arteries and was only slowly carried into the smaller arteries and arterioles. This slow movement was probably partly due to the peripheral arterial pressure as suggested by the closely conglomerated mass of red cells behind the column of air (Fig. 5). It was also partly due to surface tension resistance as suggested by the bulging of the vessel wall at the site of the air column (Figs. 5 and 10). As these air emboli were slowly carried toward the arterioles, they were broken with difficulty into smaller lengths usually at arterial branchings so that they often appeared to block or straddle branching arteries.



Fig 6 Punctate hemorrhage in capillary of rabbit's mesentery. Note the red cells extravasated from the most engorged part of a terminal district $\times 55$



Fig 7 Same punctate hemorrhage shown in Figure 6. Note the intact vessel wall, engorged capillary, and collapse beyond the site of extravasated red blood cells $\times 215$

Contrary to the observations of Hewson we could neither establish any definite coagulative action of the air on the blood nor was there any special relation of air emboli to the agglutination of red cells. In many microscopic fields transient stasis lasted as long as half an hour on either side of an air embolus with conglutination of blood cells while in other fields this conglutination was followed by rapid and extensive agglutination. The very early separation of blood cells from fluid constituents in the arteries was notable however, in every experiment. When agglutination occurred (following permanent stasis) the air was, of course, blocked in the arteries, but when conglutination occurred (during pre-stasis or transient stasis) the air often slowly disappeared on reaching the arteriole. This disappearance always occurred at a fixed point at the peripheral end of the air column and could only be explained as a diffusion of the air into the Ringer's fluid. When the column had completely gone there occurred an immediate rapid increase in blood movement through the arteriole and its peripheral terminal district.

2 *Changes in caliber of vessels and in blood movements.* Following the air injection muscu-

lar arteries at once showed many long or short constricted segments of variable degree some were completely closed while others were only slightly narrowed. These constrictions disappeared in 2 to 3 minutes. They sometimes remained at their original site, but more often progressed in slow irregular peristaltic waves toward the smaller arteries, never however reaching into the arterioles. It was a notable fact that these transient constrictions were much more marked, and in some instances only occurred at all after the first injection of air. The smaller caliber of the muscular arteries was associated with a marked decrease in the speed of blood through them. The vasoconstriction extended also into the terminal segments so that in many areas the capillary bed was completely closed while in other areas capillary loops opened only for short intervals to permit the relatively slow passage along their course of separated masses of blood cells and fluid. Dilatation of the muscular arteries at the end of 2 to 3 minutes was associated with a gradual increase in the speed of the blood stream. The constriction of terminal segments was apparently independent of that of the muscular arteries because it was irregularly distributed and of

ASPIRATION BIOPSY

HALES E. MARTIN M.D. F.A.C.S., AND EDWARD B. ILLIS New York

Memorial Hospital

IN 1930 we reported (5) 65 cases of malignant tumors in which we had obtained material for histological diagnosis by aspiration of the tumors with an ordinary 18 gauge needle and record syringe. Since that time the method has been generally employed by the clinical staff of Memorial Hospital wherever indicated and on January 1, 1934 positive diagnoses had been made by this method in over 1,400 instances (Table I). Ferguson, Sharp and Coley and Sharp have reported on the aspiration of certain clinical varieties of tumors. Stewart has recently reported his pathological interpretation of aspiration biopsies done at our hospital. Klinger and Burch have described a modification of the method by which the uterine cavity is aspirated with a blunt tipped copper tube attached to a syringe. Forster has applied the method in suspected brain tumors aspirating through a small drill hole in the skull. Judging from the general acceptance of the method in all clinical departments of our institution we feel that it has been proved to be a safe, reliable and time-saving procedure in tumor diagnosis and that it has been the only justifiable means of obtaining material for histological examination in the great majority of cases in which it has been employed.

The indications for aspiration biopsy are tumors which lie below the surface of normal tissue where tissue cannot be obtained otherwise, except by a surgical incision through normal tissue. In growths which are ulcerated on the surface larger and more satisfactory biopsies can be obtained by the usual methods.

We believe that histological diagnosis is highly desirable in all and absolutely essential in the majority of suspected neoplasms, in order that the proper therapeutic measures may be outlined. Biopsy by surgical incision through normal tissue may be followed by serious complications in the more malignant growths. Ewing has long been an active opponent of surgical biopsy made through nor-

mal tissues especially in suspected tumors of the breast and long bones. His objections to surgical biopsy in such cases are that such a procedure modifies the clinical setting, breaks down the natural local barriers to the spread of the disease and favors early metastases and fungation of the growth through the surgical wound. These views are quite generally accepted in regard to deeply situated tumors. We believe however that there is little risk in carefully removing a small biopsy from an exposed ulcerated surface or in entirely excising a movable superficial, isolated node.

Aspiration biopsy has, we believe, few if any of the objections of surgical biopsy in tumors below the surface of normal tissue. The risk of dissemination of metastases through the tiny break in the capsule such as will be caused by an 18 gauge needle, is comparatively slight. We have not observed any alteration in the clinical setting in any of the cases herein reported. The procedure is accepted casually by the patient as part of the routine examination. It can be done in a few minutes with little discomfort. If novocain is judiciously distributed along the more sensitive portions of the proposed needle puncture. No hospitalization is required and the procedure can be done in any clinic or office without any special preparation or apparatus, except an ordinary 18 gauge needle and record syringe.

One of its greatest advantages is in saving time in arriving at a definite diagnosis, so that the nature and order of the therapeutic measures may be immediately planned and discussed with the patient and family. The aspiration itself including the assembling of the apparatus and preparation of the patient takes only about 15 minutes, and the smear can be stained and examined microscopically in about 10 minutes more. The numerous advantages of such an easy rapid procedure as compared to the laborious preparations and

delay following a surgical biopsy requires no further comment

TECHNIQUE

We have not found it necessary to alter our technique from that published in the original report. The special instruments required are an ordinary 18 gauge needle 5 to 10 centimeters in length (which should be new or recently sharpened), and a 20 cubic centimeter record syringe. Needles of about 15 to 20 centimeters in length are sometimes required for aspiration at greater than average depths as for instance in the lung or prostate. Glass slides are necessary for smearing the specimen, and a specimen bottle with 10 per cent formalin if a portion of the tissue is to be treated as a regular biopsy.

The skin at the site of the intended puncture is painted with iodine and a small area of skin infiltrated with 1 per cent novocain. In particularly sensitive regions some of the local anæsthetic is injected continuously along the line of the intended puncture down to the tumor. With a bistoury pointed scalpel (No. 11 Bard Parker blade) a stab wound is made through the skin with the instrument held at right angles to the skin surface. This puncture of the skin facilitates insertion of the needle and prevents contamination of the aspirated material by surface epithelium. An 18 gauge needle attached to a tightly fitting record syringe (with the piston closed) is then inserted and advanced slowly through the superficial tissues until the point is felt to enter the suspected neoplastic mass (Fig. 1). Guided by palpation with the disengaged hand it is striking how readily a difference in consistence of the tissues can be felt as the point of the needle enters a mass of neoplasm. When the point of the needle is felt to enter the tumor the piston of the syringe is partly withdrawn so as to produce a vacuum (Fig. 2) and the needle is then advanced 1 to 3 centimeters further depending on the anatomy and size of the tumor (Fig. 3). Maintaining the vacuum the needle is then withdrawn to the same distance advanced again and withdrawn thus maintaining the vacuum constantly and keeping the point of the needle within the tumor. Tissue from the tumor

TABLE 1—POSITIVE DIAGNOSES OF CANCER MADE BY ASPIRATION BIOPSY AT MEMORIAL HOSPITAL

	Cases
Cervical nodes or tumors, including the parotid and submaxillary salivary glands	662
Breast	280
Bones	140
Prostate	55
Lung	41
Upper and lower jaws	27
Thyroid	17
Tonsil	15
Antrum	15
Base of tongue	11
Miscellaneous (axillary and inguinal nodes, intra-oral tumors, orbital, various soft part tumors, etc.)	142
Total	1405 ✓

mass enters the needle and is held within it both by a punch action of the advancing needle and by suction of the vacuum. *Care must be taken that the vacuum is maintained while the needle is manipulated within the tumor. Aspiration by suction alone, with the needle at rest is not sufficient to draw tissue into the needle in most cases and is the most common cause of failure to secure tissue.*

Before the needle is completely withdrawn from the tissues the piston must be slowly released the syringe detached and the needle withdrawn separately (Figs. 4 and 5), otherwise any remaining vacuum may cause the aspirated material to be suddenly drawn into and splashed over the interior of the syringe, making its collection more difficult. If the tumor is fairly firm in consistence, blood or tissue usually do not appear in the syringe but the needle will be found to contain material. In soft and vascular tumors a small quantity of blood mixed with fragments of tissue may enter the syringe while the needle is being advanced and withdrawn, or a solid cylindrical mass of tissue may appear.

After complete withdrawal of the apparatus the syringe is partially filled with air again attached and the contents of the needle slowly and carefully expelled on to a glass slide (Fig. 6). If there is much resistance to expelling the plug of tissue from the needle by the air filled syringe it is safer first to push part of the tissue out of the needle with the wire obturator otherwise with great pressure the plug may suddenly pop out and be

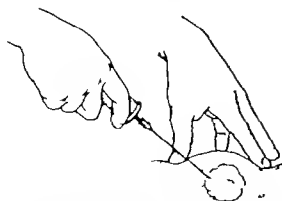


Fig. 1. An 18 gauge needle attached to a record syringe is inserted through the skin, guided by the palpating hand, until the point of the needle is felt to enter the tumor.

lost. If only a smear of the specimen is desired any excess of fluid or blood is carefully blotted off with gauze and a second slide placed over the first, and with *firm pressure* crushed very thin and drawn once across lengthwise (Fig. 7). Tumor tissue having little intercellular supporting substance will usually smear out in a thin film which is quite characteristic. If the needle is found empty and there is any blood or other material in the syringe a careful search should be made of this material rolling the syringe between the eyes and a source of light. Any fragment of tissue may be then fished out on to the glass slide and smeared. If the material within the syringe seems to be composed of blood this may be poured into a centrifuge tube and allowed to

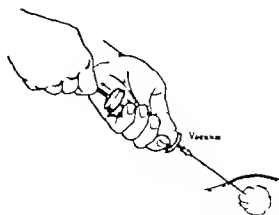


Fig. 2. With the needle stationary a vacuum is produced in the syringe by partly withdrawing the piston.

clot. The clot is later removed and sectioned like any large biopsy and will be found to contain all tissue fragments firmly bound together.

Preparation of the specimen. The material may be prepared for examination by two methods: one the immediate fixation and staining of the smeared slide and the second the collected fragments, either alone or embedded in a blood clot, are fixed and treated as any small biopsy. Patton routinely expresses the plug of tissue from the needle into a centrifuge tube containing 1 to 2 cubic centimeters of blood freshly drawn from a vein.

In our earlier observations, we attempted to secure fixed paraffin preparations for confirmation of the stained smear in all cases. After further experience of our pathological staff in interpreting the smears, we have omitted the more tedious and time consuming paraffin sections, except in certain cases in which such preparations would be of particular value or interest in diagnosis. Since one of the chief values of the method is the immediate reading, the stained smear will probably be found more generally practicable.

The immediate method. The fresh tissue fragment on the glass slide is smeared by firm flat pressure by another glass slide drawn once across (Fig. 7). The smeared slide is fixed by heating gently over a gas flame until warm and dry and is then prepared according to the following technique:

1. Alcohol (95 per cent)—one minute

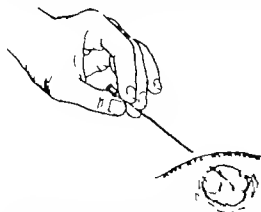


Fig. 3. The needle, which supposedly contains a plug of tissue from the tumor, is then withdrawn separately from the tissues.

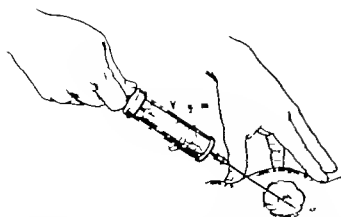


Fig. 3 Maintaining the vacuum, the needle is then advanced a distance of 1 to 3 centimeters depending upon the size of the tumor

- 2 Water—one minute
- 3 Haematoxylin—one minute
- 4 Water—one minute
- 5 Check by microscopic examination of the cellular stain, and if sufficient proceed, or if insufficient return to haematoxylin for deeper staining
- 6 Eosin—one minute—check stain microscopically
- 7 Alcohol (95 per cent)—one half minute
- 8 Carbol xylol—one half minute
- 9 Xylol—one half minute
- 10 Mount with Canada balsam and cover glass

The longer method The remainder of the specimen consisting of the collected tissue fragments or the blood clot containing them is treated as any small biopsy, being carried through the stages of alcohol fixation and embedding in paraffin great care being taken to collect and mass every minute particle of tissue since a positive diagnosis may be obtained from the smallest fragment. Absolutely fresh 52 to 56 degrees C paraffin should be used for embedding and all particles massed

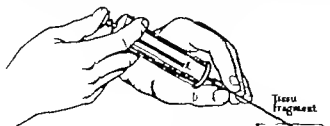


Fig. 6 The needle is again attached to the syringe and the plug of tissue is expelled on to a glass slide.

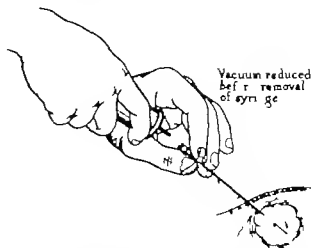


Fig. 4 Maintaining the vacuum the needle is then withdrawn to the starting point. This manipulation may be repeated once or twice, with a slight change in the direction of the needle. The vacuum in the syringe is gradually released and the syringe is detached from the needle before withdrawal

together on the block and cooled immediately on ice. Every section cut from the block should be examined for fear that in dealing with such small particles one might lose the opportunity of making a positive diagnosis. We usually cut 6 to 8 sections and place them on a single slide. These are carefully examined and further sections cut, if the first are negative and more material remains on the block.

In case a reading is desired earlier than by our routine laboratory technique we use the following method of preparation which requires about 3 hours.

The quick paraffin method

- 1 Formalin 10 per cent—ten minutes

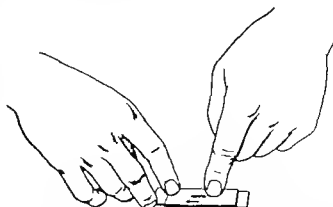


Fig. 7 A portion of the tissue fragment is smeared by firm, flat pressure with another slide, drawn once across, for immediate staining. A portion of the plug may be placed in alcohol for fixation and section by the usual method.

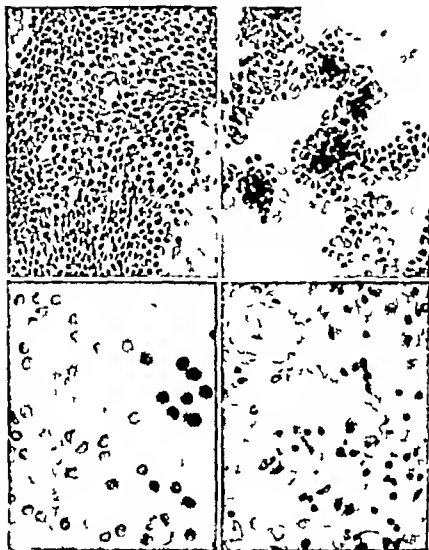


Fig. 8 Stained smears of aspirated material: 1. Fibro-adenoma of breast, cells small, regular, coherent; 2. Carcinoma of breast, cells hyperchromatic and loose; 3. Plasma cell myeloma; 4. Gaucher's splenomegaly.

2. Alcohol 95 per cent—two changes, ten minutes each.

3. Xylol—two changes, one-half hour each.

4. Paraffin 56 degrees C—two changes, one half hour each. (First three steps in incubator 37 degrees C.)

5. Cut and stain.

PATHOLOGICAL INTERPRETATION

The interpretation of smears of material obtained by aspiration requires, first of all, a sympathetic attitude of the pathologist, and

refusal on his part, to consider the procedure naturally means that no progress can be made in this rather difficult field of diagnosis. Stewart has discussed in detail the pathological interpretation of aspiration biopsies. The pathologist may readily obtain experience in this field by smearing fresh fragments of tumors from the operative or autopsy specimens in his laboratory.

One might ask what information may be obtained from a smear of aspirated material. One hopes at least to determine whether or

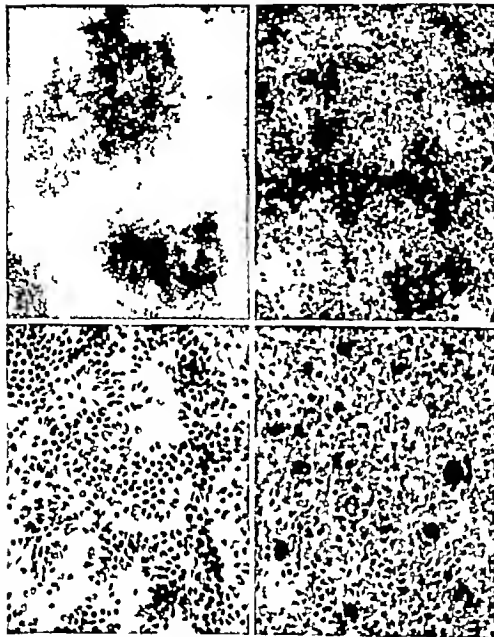


Fig 9 Stained smears of aspirated material. 5 Mixed tumor of parotid much mucin and atypical cell group (low power $\times 110$) 6 Transitional cell carcinoma, tonsil. 7 Epidermoid carcinoma, lung 8 Pigmented melanoma large pigmented cells

not a malignant tumor is present and whether it is of epithelial or of connective tissue origin. In some instances that is all one learns from the smear alone. If a plug of aspirated tissue is fixed, cut, and stained by the usual methods the preparation differs from ordinary sections only in that it is small.

In our laboratory no diagnoses are rendered from aspirated material without reasonably full clinical data, since an accurate knowledge of the exact source of the material is of major

importance. Knowing the source, knowing what tumors are apt to occur in the region, and being fully cognizant of the histological criteria for diagnosis of such tumors from ordinary sections, one may form from the various minutiae of the smear a sort of composite picture which permits a visualization of the probable histology of the process and hence a diagnosis of the type of tumor. Difficult at first, this becomes easier with experience. Except that the cell arrangements

are lost, the diagnostic criteria are the same as in sections prepared in the usual manner.

If the aspirated material is partly liquefied or necrotic, histological diagnosis may be more difficult than with viable tissue and requires interpretation derived from a consideration of the region involved, the treatment administered if any and a knowledge of the changes likely to have occurred under the circumstances. The following illustrations may be offered as to the possible interpretations. If a smear from an aspirated cervical node contains caseous necrotic material, rare large acidophilic flattened cells and numerous giant cells, the flat acidophilic cells suggest sloughing squamous carcinoma, the caseation and giant cells suggest tubercle. The combination indicates a broken-down cystic cervical node, metastasis of epidermoid carcinoma, probably irradiated with necrosis and a foreign body giant cell reaction to necrotic squamous pearls. In another case if the smear from an aspirated cervical node or mass in the region of the carotid bulb presents sloughing squamous epithelium and large sheets of lymphoid tissue, the diagnosis lies between metastatic carcinoma and branchiogenic cyst. Either will yield sloughing squamous epithelium.

Let us assume that no primary tumor can be found in the oral cavity or upper respiratory tract. When a metastatic node is sufficiently large to yield sloughing squamous cells that is, when cystic degeneration has occurred, it will be found that the lymphoid elements of the node are completely replaced by the tumor. Hence, if we find large numbers of lymphocytes in the smear, the indicated diagnosis is branchiogenic cyst, since much lymphoid tissue is often present in the walls of such cysts. With this much information at hand surgical exploration becomes justified.

The finer histological classifications and grading of tumors cannot be made from aspirations. For instance, one cannot hope to classify the various anatomical sub-varieties of mammary cancer. As a rule, the probable behavior of a lesion to radiation cannot be predicted, although at times this has been possible. It is possible to carry the discussion of diagnostic criteria through much of the realm

of regional diagnosis of tumors by aspiration, but this would lead us into much descriptive pathological detail which is foreign to the purpose of this paper and which has already been published by Stewart.

CLINICAL APPLICATION

As previously stated, the procedure is indicated in any case of suspected malignant tumor in which the lesion lies below the surface of normal tissue. Its particular advantages in various anatomical localities merits a more detailed discussion.

Cervical adenopathies or tumors. In our clinic at Memorial Hospital we receive a large number of cases referred because of enlarged neck nodes or cervical tumors. In most of these cases a thorough search of the upper alimentary and respiratory tracts immediately discloses the primary lesion. In others, no primary lesion is found at this first examination and the question of differential diagnosis rests among the following possibilities, as shown by our experience:

1. Metastasis from an undiscovered primary lesion of the upper alimentary and respiratory tracts.

2. Metastasis from a visceral primary, such as stomach, kidney, lung, etc. ✓

3. Inflammatory hyperplasia of lymph nodes.

4. Malignant lymphoma—Hodgkin's disease, lymphosarcoma.

5. Adenopathy of the leukemias.

6. Tuberculosis.

7. Syphilis.

8. Actinomycosis ✓

9. Primary cervical tumor—branchiogenic carcinoma, carcinoma of the thyroid, neurogenic sarcoma, liposarcoma, carcinoma of the submaxillary salivary gland, etc.

10. Branchiogenic cyst. ✓

One should consider the laborious, expensive and time-consuming procedures such as the Wassermann test, roentgenograms of the chest and gastro-intestinal tract, and blood counts necessary to rule out many of these possibilities only to be forced eventually to depend on surgical biopsy. Immediate diagnosis is extremely urgent in the case of a lethal disease such as cancer.

We make it a routine procedure to aspirate all cervical adenopathies of unknown nature. The patient waits until the smear is stained and examined microscopically. If a report of "epidermoid carcinoma" is returned the probabilities are that an undiscovered primary lesion exists somewhere in the upper alimentary or respiratory tracts and repeated further examinations of the pharynx are made. Although cervical metastases may be quite evident the primary lesion in the nasopharynx or at the base of the tongue may be so small as to escape detection by the first clinical examinations. Although treatment may be instituted to the cervical nodes, pending further examinations the diagnosis is considered incomplete until the primary is discovered by repeated examinations.

Most cervical adenopathies in the adult are malignant and are usually metastatic from intra-oral or pharyngeal cancer. We have been able to make histologically verified diagnoses in clinically doubtful cases of such primary cervical neoplasms as branchiogenic carcinoma, carcinoma of the submaxillary salivary gland, neurogenic sarcoma, carcinoma of the thyroid and liposarcoma. Strongly presumptive diagnoses may be made in the cases of Hodgkin's disease and lymphosarcoma.

In benign cervical adenopathies and tumors aspiration is often of great assistance. Clear straw colored, or even slightly bloody fluid, from an apparently solid or cystic mass at, or slightly above the carotid bulb makes a diagnosis of branchiogenic cyst almost certain. The same type of material from a mass in the midline of the neck near the level of the hyoid bone indicates a thyroglossal cyst. Stewart of our pathological laboratories has repeatedly diagnosed tuberculosis, and on one occasion actinomycosis, from the appearance of the smear. With such a lead in the majority of these cases, we have been able to confirm the diagnosis by further clinical or laboratory examinations.

In clinics where neck dissections are practiced routinely, histological material is always available for record. In our clinic, neck dissections have been largely given up in favor of more conservative means. The metastatic nodes of the more anaplastic and radiosensu-

tive varieties (especially pharyngeal) are subjected to external irradiation at the same time as the primary lesion. If they do not regress with the primary, radon gold seeds are then implanted either after surgical exposure of the nodes, or through skin punctures. In either case, no surgical biopsy is done, and histological verification of the actual presence of cancer in the nodes is essential for such treatment methods are to be evaluated accurately 3 to 5 years later. We therefore make it a practice to aspirate all such nodes for record. If the node is surgically exposed for the gold seed implantation, it is aspirated in the operating room, after its outer surface has been exposed, preparatory to implanting the seeds.

Tumors of the oral cavity, oral and nasal pharynxes and paranasal sinuses. Most tumors of the oral cavity are ulcerated on the surface from which a regular biopsy can be taken. On the other hand we have repeatedly found carcinoma of the base of the tongue presenting as massive palpable tumors with no apparent surface ulceration. In these cases aspiration is readily accomplished through the midline of the neck just above the hyoid bone thus avoiding a painful, difficult surgical incision into the tumor.

Carcinoma of the antrum erodes the bony walls and produce in the cheek without any swelling. Quite commonly, such growth ulcerated and fungating into the mouth of the same side, from which a biopsy can be obtained. If there is no swelling and the nasal cavity is clear, it can be obtained by aspirating directly through the cheek or hard palate at a site where no swelling occurs indicating perforation of the walls.

Carcinoma of the ethmoid erodes the medial wall of the orbit and presents at or just below the eye as a soft or cystic swelling under the skin. It may be aspirated for diagnosis.

Tumors of the pharyngeal wall, tongue, palate, or cheek may present bulging surfaces without ulceration to which an aspirating needle may be easily and painlessly inserted (Fig 9 & 10).

oma is a dangerous cyst, and central tumors of the jaws are not always differentiated roentgenographically. Aspiration usually obtains sufficient material to permit a diagnosis when supported by clinical and X-ray findings. In suspected cases in any of these regions, a diagnosis of a cyst or abscess is often made by aspiration.

Tumors of the parotid. Benign mixed tumors and malignant carcinomata of the parotid gland are readily differentiated clinically if characteristic features of either one are present. However, we have repeatedly seen highly nodular, firm, movable tumors of long duration which proved to be true malignant carcinomata of the parotid capable of metastases. We have also observed cases of early soft, fixed tumors of short duration which were benign mixed tumors. A knowledge of the histological nature of a parotid tumor is of paramount importance in our treatment.

Mixed tumors if operable require surgical excision while in the most cases infiltrative removal is impossible. Deforming operations are only followed by prompt recrudescence and widespread metastases. In our opinion, the latter should all be treated by irradiation. Aspiration biopsy renders a correct diagnosis in most cases, and permits of a rational plan of procedure (Fig. 9-5).

Breast tumors. The procedure has assumed a definite part of the routine in the diagnosis of breast cancer at our hospital under the direction of the late Dr. Burton J. Lee. If the disease is well established so that the clinical diagnosis is assured and the proposed method of therapy is to be radical excision, aspiration biopsy is of particular value from the practical standpoint. The breast and axillary region are exposed for pathological examination. There is no harm in such case.

Its chief value in the diagnosis of disease of the breast and axilla may consist in the psychological and psychological aspects frequently met with

in a nervous and apprehensive woman who may have digested the current propaganda in regard to the early recognition of cancer, discovers a lump in her breast. She immediately consults her surgeon or is referred to a surgeon for an opinion. A definite mass is found in the breast which in all probability is cancer but which in the surgeon's opinion might be of a benign character. The surgeon is then faced with the following alternatives. To recommend a radical amputation of the breast for what might turn out to be a benign condition, to admit the uncertainty of his diagnosis and request a consultation to secure permission for a local removal and frozen section, and an immediate radical amputation if the tumor is found to be malignant. In any case, an apprehensive patient and the family are kept under suspense until the operation is completed and the surgeon proceeds under the mental handicap of uncertainty which he must in all fairness, confess to the family at least.

If under the same circumstances, the surgeon suggests aspiration biopsy on the first visit, the atmosphere of doubt, uncertainty and indecision will, in most cases, be removed. Permission for aspiration is readily obtained if it be explained that it is a necessary test after which a definite opinion can be given. If the report of the smear is carcinoma, a confident attitude may be taken by the surgeon in regard to the proposed method of treatment. In other cases an immediate opinion may be given that the condition is benign and local excision or observation only advised.

operation begun with a view to a possible amputation and after frozen section completed, local removal of a benign tumor will result in an unsightly deformity of the breast. Incision into the breast for frozen section followed by radical amputation at the time of operation, from the ethical standpoint, at least, involves an unnecessary risk of

delaying the diagnosis of carcinoma, and that it may be a contraindication in certain general conditions.

the evidence of pulmonary or bony metastases, or the youth of the patient. In these situations the prognosis following surgery is uniformly bad, and at our hospital, their treatment by some form of irradiation is recommended. In Lee's and Adair's opinion, even surgical biopsy is to be avoided in these cases since it modifies the clinical setting and renders subsequent irradiation by any method more difficult and unsatisfactory. Aspiration serves to verify histologically the clinical diagnosis of cancer in these cases for record (Fig 8, 1 and 2).

At the present time, immediate aspiration is employed almost as a routine diagnostic procedure on the breast service at Memorial Hospital if the least possibility of mammary carcinoma is considered. Positive diagnoses of breast carcinoma have been obtained in 280 instances at Memorial Hospital. The procedure is employed not only for primary breast lesions but for diagnosis of questionable axillary or supraclavicular nodes.

Lung tumors Bronchoscopy has definite narrow limitations in the diagnosis of thoracic tumors. Positive diagnoses of lung cancer can be made bronchoscopically only if the growth arises in, or has ulcerated through, the wall of one of the lower or middle lobe bronchi, the trachea, or at the proximal end of either upper lobe bronchus so that a biopsy can be removed. Except where the lesion presents itself so that a biopsy can be removed bronchoscopic evidence is presumptive only. It must be admitted that monocular inspection through an instrument of such a narrow caliber as a bronchoscope would be considered entirely insufficient for diagnosis in the exposed accessible portions of the body, where adequate inspection and palpation are possible. If the tumor lies within the parenchyma of the lung or arises in an upper lobe bronchus aspiration offers the only justifiable means of biopsy (Fig 9, 7).

For lung aspirations, longer 18 gauge needles of 15 to 20 centimeters are advisable. It would seem on first thought that there might be considerable danger in puncturing a large bronchus or blood vessel but we have observed no untoward results in 41 instances. We have undoubtedly punctured the larger

bronchi on several occasions, as evidenced by withdrawal of air into the syringe, and the spitting up of a few drops of blood. No serious or even significant effects were noted except as above mentioned. While we have always attempted to avoid the neighborhood of the vena cava or aorta, we have undoubtedly punctured blood vessels of considerable size in several instances, since the syringe partly filled with blood. In these cases, there was also a complete absence of any significant sequelae.

Before an aspiration of a lung tumor is attempted a careful study of the chest X ray should be made locating the tumor in its relation to the intercostal spaces and its position in the transverse axis. A stereo X ray examination aids in determining its position in anteroposterior diameter so that it may be approached from the nearest point, either on the anterior or posterior chest wall. After a preliminary hypodermic of morphine and rather deep novocain infiltration of the chest wall down to and including the pleura, the procedure is usually best accomplished in a sitting position.

Abdominal tumors The aspiration of abdominal tumors which might be superimposed by intestines would, of course, be a dangerous procedure, and we have not attempted it. In situations where the tumor certainly lies against the abdominal wall, without any possibility of intervening gut, there is no logical objection to the procedure. In 5 instances we have aspirated masses in the liver which lay immediately next to the abdominal wall. Material, sufficient to prove the presence of carcinoma, was obtained in all instances, but the type could not be determined. We have twice aspirated the spleen for suspected Gaucher's disease (Fig 8, 4). Positive diagnoses were possible in both from the smeared material, these diagnoses were confirmed after splenectomy by one of us (Mason) in both cases. No general rule can be made for the advisability of aspiration in abdominal tumors, and the indications must be determined independently in each case. At laparotomy tumors may be exposed from which, for some reason the surgeon hesitates to remove a biopsy by the usual methods. Such tumors

may be aspirated for confirmation of the clinical diagnosis. Histological material showing cancer has been obtained on two occasions by the aspiration of tumors of the stomach wall and in one instance a mass in the wall of the sigmoid has been aspirated with a histological report of cancer.

Bone tumors. The classification of bone tumors by X ray examination is sometimes impossible and we know of no situation in which the differentiation between a benign and malignant tumor is more commonly attended by so much discussion and difference of opinion. We see no valid reason why such cases should not be subjected to immediate aspiration which, in many cases, will render superfluous any further discussion from the diagnostic standpoint. Without a definite diagnosis opinion may be divided between amputation, local excision with curettage and external irradiation only. Surgical biopsy of bone tumors is undesirable or a dangerous procedure, if the tumor should be malignant. Amputation of a limb for a suspected malignant tumor which proves to be benign is a tragic error which

may be avoided in many cases of aspiration. The local changes following the necessarily heavy irradiation for malignant tumors treated by that method alone are certainly justified in certain instances if a reasonably functioning limb may be spared thereby. The same sequelae are however not always justified if a benign tumor is treated in the same manner under a mistaken diagnosis.

Accurate classification as to type is not possible from the smear in bone tumors except in some cases of benign giant cell tumors and endothelial myeloma, where definite cell forms or arrangements may be evident in the smeared preparation. However if material is obtained it is usually possible to differentiate between a benign and malignant growth. On such data, coupled with the history, physical examination and the roentgenographic findings, a correct diagnosis is obtained, sufficient at least to advise proper therapy.

(Fig. 8, 3) Diagnoses in 140 instances of bone tumors have been obtained by aspiration in our hospital. In one case a diagnosis of echinococcal cyst was made by aspiration of a tumor of the pelvic bones which had been

repeatedly diagnosed by X ray examination in several clinics (ours included) as osteogenic sarcoma over a period of one year.

Coley and Sharp reported 35 cases of aspiration biopsy in bone tumors. They found it of advantage to use a short gas anesthetic in certain cases in which some resistance was anticipated in puncturing the cortex of bone which was only partially destroyed by the growth. A short gas anesthesia is undoubtedly advantageous in the aspiration of many bone tumors especially in apprehensive patients.

Carcinoma of the prostate. Biopsies from cancer of the prostate were formerly practically never obtained except after surgical excision of the gland or at autopsy. Cases in which patients were treated by conservative measures therefore lacked conclusive diagnostic data. In most instances Ferguson has developed a technique for aspiration of the prostate through the perineum and there are at this time, 55 cases in the records of our pathological laboratory. Ferguson uses a specially made 18 gauge needle 75 centimeters in length which may be locked on to the syringe and containing an obturator. The skin and superficial tissues of the perineum are infiltrated with novocain and the needle with the obturator in place is inserted through the perineum with a guiding finger in the rectum which palpates the enlarged prostate and directs the needle into it. The obturator is then removed and the syringe attached. The remainder of the technique is as we have described. No untoward after effects have been noted even though Ferguson admits having inadvertently punctured the bladder on several occasions.

Miscellaneous tumors. Suspected metastatic nodules or tumors, recurrent after either surgical excision or irradiation supply a fruitful field for aspiration (Fig. 9, 8). In many of these cases it is extremely difficult to differentiate between recurrences of malignant disease and masses of scar tissue, inflammatory lymphadenopathies, slowly absorbing hematoma, or traumatic fat necrosis. In such cases, one does not feel justified in subjecting the patient to surgical biopsy or in proposing surgical excision or further irradiation without more conclusive evidence. Rather than

wait for more definite clinical evidence and a worse prognosis the question can usually be definitely settled by aspiration.

Tumors of the skin are usually ulcerated and superficial, but we have repeatedly obtained tissue from deeply infiltrating basal cell carcinomata of the eyelids or the region of the canthi where surgical biopsy would have been objectionable, because of laceration of the tissues. After aspiration, the patients were treated by implantation of radon seeds.

Histological examination of tissue is essential in the treatment of neoplastic disease not only in outlining treatment, but for purposes of record. Only 5 year cases are considered as conclusive evidence of the value of any particular treatment method. Unsupported by biopsies, clinical diagnoses 5 years old whether made by oneself or by others, cannot avoid being viewed with some doubt, if the cases have done particularly well. At our hospital statistics are based only on cases having histological examinations. Biopsy by surgical exposure is too often extremely ill advised when casually performed by a surgeon who contemplates giving no further treatment himself and it should be severely condemned when done in this manner without careful consideration and definite purpose. Biopsy by needle

puncture and aspiration has, we believe, few, if any disadvantages to the patient from the surgical standpoint and has in our experience, proved to be a safe, reliable diagnostic method in many cases in which surgical biopsy is contra indicated.

SUMMARY

The indications for, and the technique of biopsy by needle puncture and aspiration are described in detail. Over 1,400 positive histological diagnoses of cancer have been made by this method at Memorial Hospital.

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THE SYMPTOM-COMPLEX OF COMPLETE EXTERNAL PANCREATIC FISTULA

REPORT OF A CASE¹

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THE physiology of the external secretion of the pancreas is now rather well known but the clinical syndrome and the pathological significance of the loss of this important secretion to the body are still generally unrecognized if one can judge by the literature on the subject. It is our purpose to report a clinical example of this condition substantiating in the human subject the recent experimental work done. The deductions to be drawn may go far to explain the clinical findings in many of the pancreato-biliary group of diseases.

EXPERIMENTAL INVESTIGATIONS

Pavlov and others early noted various digestive disturbances following the establishment of an open pancreatic fistula in dogs, but hypersecretion followed by death was regarded as an exceptional occurrence. Pratt showed in 1916 that the exclusion of the pancreatic juice from the intestine by section or evulsion of its ducts caused a marked disturbance in the absorption of nitrogen and fat. But it was not until 1926 that Elman and McCaughan (8) first clearly demonstrated that these adverse effects were due to the removal of some necessary substance from the body and its excretion to the pancreatic juice. When the entire output of the external secretion was excluded from the intestine by an improved fistula to the outside death invariably resulted in from 5 to 8 days with marked metabolic disturbances. Using a more indirect method (acute duodenal fistula) Walters and Bollman likewise came to the conclusion that the loss of pancreatic secretion for any length of time was incompatible with life whereas the loss of bile and duodenal secretion was without lethal effect. More recently Gamble, Laqua and Dragstedt (6) with their associates have carried on experimental work which has confirmed these results.

A uniform lethal syndrome was exhibited after operation, characterized by striking anorexia, vomiting, marked asthenia and loss of weight and pronounced dehydration. The significant metabolic changes were a rapidly progressive anhydramia (plasma volume as low as one fifth of total blood volume), a slight acidosis, a moderate decrease in the blood chlorides, and an elevation of the blood urea nitrogen shortly before death. Postmortem examination was invariably negative except for mild chronic inflammatory and degenerative changes in the pancreas. In animals in which few or no deleterious effects were observed and death failed to occur following apparent complete external fistula accessory ducts were found on sacrificing the animals, showing that the pancreatic loss was subtotal.

The pancreatic juice collected from these fistulas possessed practically no power to digest proteins—an observation which was first recorded in Pavlov's laboratory by Schepowalnikoff and has since been repeatedly confirmed. It was shown that the inactive trypsinogen must be activated by enterokinase—a secretion of the duodenal mucosa, such being the normal mechanism. It has since been observed that trypsinogen may, in certain instances, be activated by bile, calcium in the blood or plasma and by bacteria.

The essential cause of early death in these animals was not apparent. The comparatively slight alteration in the blood chemistry gave little evidence of the profound general disturbance noted. Analogies to high intestinal obstruction and to gastric or duodenal fistula were drawn although in these conditions the blood chemistry changes were admittedly much more striking. However, Jenkins, working on high intestinal obstruction in dogs, prolonged life considerably by short-circuiting the pancreatic, biliary and duodenal secretions below the point of obstruction either

permitting essential reabsorption in the lower bowel or preventing the formation of a toxin in the obstructed loop. Anhydremia alone is known to alter the composition of the blood and to lead to a fatal termination (15, 18, 27). Certainly this was one of the most marked disturbances in the dogs with lethal pancreatic fistula. It was generally agreed by most of the experimenters that the loss of salts, water, and protein by way of the fistula and gastric vomitus, and their failure of reabsorption in the lower intestine played quite an important rôle in the pathogenesis and early death in this condition.

This supposition was attested by the uniformly beneficial results which were obtained by the use of daily intravenous injection of Ringer's solution or of physiological salt solution. Under such therapy, the normal chemistry of the blood was maintained and life greatly prolonged. Apparent restoration to a normal state in a moribund dog was also secured by the oral administration of whole pancreatic juice, the intravenous infusion of which failed to have such a benefit.

CLINICAL STUDIES

External fistula of the pancreas was apparently unknown until the advent of abdominal surgery with special reference to operations for inflammations, cysts, stones and injuries of the pancreas. The necessary institution of drainage in such cases to prevent the discharge of pancreatic secretion into the abdominal cavity provided the source for such fistulas. The first mention of a human pancreatic fistula was by Rommelaere, a Belgian, in 1877. Pfaff reported the first case in this country in 1897. Interestingly enough the fistula, which lasted only 48 hours, followed an operation by H. W. Cushing for "an abdominal tumor." The secretion, which was alkaline and corrosive to the skin, transformed starch into sugar, split neutral fat into fatty acid and glycerin and digested proteins. Numerous case reports have appeared subsequently, most of which have dealt with pancreatic cysts and acute pancreatitis in which the loss of pancreatic juice was neither total nor permanent.

When symptoms occurred with such partial or temporary fistulas they consisted prin-

cipally of weakness and loss of weight. Cathala and Sénèque reported such a pancreatic fistula which followed operation upon a false cyst of the pancreas after an acute pancreatitis. Marked loss of weight, asthenia, and mental depression were noted, which were considerably ameliorated by reingestion of the pancreatic juice by catheter direct from the fistula. A pancreaticogastrostomy was then performed with complete recovery. It is well to note that the clear fistulous fluid in this case provoked only a slight perietal irritation around the cutaneous orifice. It digested fat, but showed a negative reaction for amylase and trypsin, although it was infected with colon bacillus which sometimes activates trypsinogen. Recently, Kahn and Klein also noted absence of digestion of the tissues around the wound in an extensive study of true pancreatic juice flowing from a fistula following operation upon a pancreatic cyst, and demonstrated that the proteolytic enzyme was present as inactive trypsinogen in such cases.

Instances of pathologically proved complete pancreatic fistula are extremely rare in the literature. After a fairly thorough journalistic survey, we were able to find only one unquestioned example of this type, although we have little doubt that others may have been observed. This case was briefly reported by Kleinschmidt as a pancreatic fistula following a Billroth II-Kroenlein resection of the stomach for a large pyloric ulcer, in which the pancreatic duct was apparently severed in freeing the duodenum from the head of the pancreas. The patient developed marked anorexia, lost 15 kilograms, and showed persistent fatty stools on a mixed diet. A second operation demonstrated the fistula to be total, and full recovery resulted in anastomosing the fistula to an upper loop of jejunum.

As Kleinschmidt states, the diagnosis of pancreatic fistula in most cases does not present any difficulty. If, after such operations as mentioned, a clear secretion is discharged which shows the cutaneous erosion and the digestive properties of pancreatic juice, there is no doubt of the diagnosis. If a permanent fistula remains which defies all conservative efforts at treatment, it is almost certain to be a fistula from Wirsung's duct rather than from

any accessory channel or pancreatic cyst. If the pancreatic secretion is completely lacking in the intestinal canal as shown by the examination of stool and duodenal contents one can conclude that the fistula is total.

However a permanent duct fistula is not necessarily total cognizance of which is not apparent in the reports of clinical cases. It must be remembered that the accessory duct of Santorini often has a definite opening into the duodenum about 2 centimeters above the ampulla of Vater. Consequently the symptom-complex resulting from pancreatic fistula will also depend upon the presence or absence of this opening and upon the amount of pancreatic secretion that escapes through it into the intestine. Even a small amount of such leakage into its rightful channel will largely mitigate these symptoms as we have seen in dogs. It is quite probable that such a situation existed in the case reported by Villaret and Justin Besancon in which an operatively proved fistula of Wirsung's duct opening directly on the wall of the abdomen discharged for 7 months with moderate weight loss as the only symptom noted.

Difficulties in diagnosis may arise, moreover when the fistulous secretion is not simple pancreatic juice. Duodenal fistulas usually produce marked cutaneous erosion due to the activated trypsin as well as striking general disturbances, and hence offer no such obstacles. On the other hand a pancreatobiliary fistula may present a baffling clinical problem which may go unsolved or unsuspected until subsequent operation or post mortem examination reveals the true situation. This is especially the case when the fistulous fluid contains trypsin in its inactive form and produces no erosion of the incision. Popper who has done considerable work on the presence of pancreatic ferments in bile observes that the demonstration of trypsin in the bile of inflamed gall bladders is difficult and unreliable even though increased diastase values give evidence of the presence of pancreatic juice in these cases. The very bile color of the discharge is apt to make one overlook the possibility of other concomitant secretions. Furthermore the large fatty stools may be incorrectly ascribed to the lack of bile

rather than of pancreatic secretion in the intestine. Just such difficulties occurred in our case.

The point we should like to stress is the potential value of the symptomatology as a stimulant to further investigation of persistent or deleterious biliary fistulas. Such external biliary fistulas were much more common in the early days of bile tract surgery when cholecystostomy was the operation of choice. No harmful effects from the protracted loss of human bile were noted by the medical authors of that period and this view has been generally held until the present time with but a few exceptions. Early experimental work appeared to show notable effects on dogs from prolonged biliary drainage unless the diet was regulated, but more recent work as noted above (3) indicates the relative innocuity of such fistulas. From the clinical side Bernays in 1883, referred to a negress operated upon by Hodgson who had a complete biliary fistula for 12 years with no impairment in health. Balfour and Ross observed 4 cases of prolonged drainage of all the bile to the surface with an average duration of 7 months and a maximum duration of 2 years in none of which were definite recognizable disturbances seen, other than anemia. Similar instances are too numerous to mention.

Wangensteen on the contrary reported 2 cases of external biliary fistula in which there were profound loss of weight and deterioration in strength ascribed to the loss of the bile. He further cited several earlier examples of similar character. Without going into details, examination of each of the above case reports in which pathological findings are recorded shows some type of obstruction at or so near to the ampulla of Vater that pancreatic as well as biliary secretion must in all probability have been diverted from the intestine and out through the fistula. A pancreatic carcinoma involving the terminal common bile duct and a gall stone impacted almost in the ampulla with stricture of the papillary orifice were noted to be the obstructing elements in Wangenstein's 2 cases. Willett's case concerned a complete obstruction of the common bile duct with the production of a biliary fistula following a cholecystotomy. The fund was noted to

be *colorless*. The patient was lost track of, but "died 9 months later," it is said "exhausted by sores produced by the discharge." Here is presented circumstantial evidence of the loss of pancreatic principle through the fistula.

In addition to impacted calculus at the ampulla, cicatricial stenosis of the orifice, and carcinoma of the pancreas and bile ducts the obstruction may of course be caused by any benign or malignant tumor of the papilla itself. The association of a postoperative fistula with just such an entity provided the material for the present case report.

CASE REPORT

H. S. B. white, housewife, aged 61 years, was admitted to the surgical service of Union Memorial Hospital for Dr. John M. T. Finney on September 17, 1935. The patient had enjoyed very good general health until 3 years prior to admission when she suffered a severe attack of epigastric pain radiating through to the back and requiring morphia for relief. The paroxysm was associated with frequent vomiting clay-colored stools, and slight jaundice for several days.

During the same year twelve similar spells of increasing severity were endured. In the following 3 years, chills replaced the pain in the attacks. In the 7 weeks before admission, the patient had four chills followed by high fever. Slight weakness and a loss of 30 pounds in weight were also observed over the 3 year period. The patient entered the hospital during an interval period.

The family history was non-contributory. The past history revealed an attack of typhoid fever at the age of 17 years without complications, an occasional attack of tonsillitis, and the extraction of three abscessed teeth the year previous.

Physical examination showed the patient to be well nourished with good color to the mucous membranes and no evident jaundice. The rest of the examination was not remarkable except for slight tenderness and resistance over the gall bladder region. Blood pressure was 118/74. Urinalysis was negative except for a very faint trace of albumin. No specimen of stool was obtained before operation. A diagnosis of chronic cholecystitis with cholelithiasis was entertained.

Operation on September 19 by Dr. Finney revealed numerous adhesions about the ascending and transverse colon, a long, slender appendix densely adherent in the pelvis, and a thick walled gall bladder containing a single stone. The pancreas, liver, and stomach appeared normal. The adhesions were freed the appendix removed and the gall bladder dissected free. The cystic duct was ligated with No. 3 plain catgut and fine silk. One cigarette drain was inserted to the stump of the cystic duct and the abdomen was closed.

The pathological report noted an obliterated appendix lumen and an atrophic, eroded gall-bladder mucosa with marked thickening and fibrosis of wall and diffuse infiltration with lymphocytes.

For several days following operation, the patient suffered moderate distention, which was relieved by routine procedures. The incision drained only a small amount of serous fluid and on the sixth day after operation the drain was removed. The patient appeared somewhat improved during the next week, except for failure to gain much strength. During this period there was a tendency to diarrhea with frequent brown fluid stools containing bile.

On October 1 the thirteenth day after operation, profuse amounts of clear yellow bile colored fluid began draining from the wound. This was followed in several days by very marked and persistent anorexia and nausea, with occasional vomiting and striking weakness. At the same time, the stools were observed to be very bulky formed, foul-smelling and clay-colored, with a large quantity of fat microscopically and chemically and with a negative test for bile. Fluids were maintained by means of repeated infusions of normal saline, and during one 4 day period by continuous intravenous cannula, 5 per cent glucose in normal salt solution being used. Nourishment consisted of such liquid and soft foods as the patient could be encouraged to take.

On the twenty-second day after operation, the patient appeared to slip into a state of complete exhaustion, apathy and shock with cold moist extremities and an imperceptible pulse. Dr. Walter Baetjer was called into consultation at this time. A blood count revealed a haemoglobin of 120 per cent and a white count of 32,000. Urine showed no acetone or diacetic acid. Obviously marked dehydration was present, in spite of the abundance of fluids the patient had been getting the previous week. With the aid of subpectoral infusion of normal saline and intravenous administration of glucose solution and blood, she rallied out of this crisis and 2 days later showed a red blood count of 4.82 million haemoglobin of 97 and white blood count of 15,800. In an attempt to relieve and circumvent the extreme anorexia and nausea, a Levine tube was passed, through which the stomach was occasionally washed and the patient fed.

At times the fistulous fluid was cloudy and had a foul odor. A culture taken during one of these periods yielded *Bacillus coli*.

On October 18, 30 days after operation, a rubber tube was inserted into the fistulous tract and the bile fluid collected in a glass receptacle. Upon appearing clear this was fed back to the patient through the nasal tube, 300 to 600 cubic centimeters being administered daily until the day before death although these amounts represented only the major portion of the total daily discharge. This resulted in no abatement in the symptoms, however and the extreme distaste for food, nausea, occasional vomiting, emaciation, tremendous exhaustion, mental



Fig. 1 above. The gross appearance of the papillomatous involvement of the ampulla of Vater. Microscopic examination revealed carcinomatous changes.

Fig. 2. Showing the marked dilatation of the duct system resulting from the obstruction at the ampulla. *a*, Common duct; *b*, stump of cystic duct.

depression, and anhydremia continued until the end. The weakness and apathy were so striking that the patient made not the slightest voluntary effort and was only moved with great difficulty. Blood chemistry on October 21 revealed non protein nitrogen 36.7, sugar 153, and chlorides 301 milligrams per cent.

The patient became irrational at times toward the end and bronchopneumonia finally supervened 48 hours before death, which occurred on October 25, 5 weeks after operation and only 3 weeks from the beginning of the fistula. The temperature, pulse, and respiration showed no significant variations from normal during the entire illness until just before death. The blood-pressure averaged 120/80 throughout except for the one instance mentioned.

The fistulous tract and the skin surrounding the wound at no time showed evidence of erosion. Furthermore, the fluid in its original form had no diges-

tive action on test with meat protein, indicating the absence of active trypsin.

The autopsy findings (by Dr. W. C. Merkel), apart from the operative region, consisted of early bilateral basilar lobular pneumonia, cloudy swelling of the heart, liver and kidneys, and right sided cardiac dilatation. A bile stained postoperative sinus tract extended from the incision to the floor of the hepatic fossa. The duodenum was opened and a papillomatous growth slightly larger than a pea was seen to occupy the site of the ampulla of Vater with obstruction and compression laterally of the orifice of the common duct. This duct was enormously dilated, measuring 1.5 centimeters in diameter with free passage into the stump of the cystic duct which communicated with the fistulous tract. No evidence of ligature was encountered. Both hepatic ducts and the main pancreatic duct with its radicals were also markedly dilated. Intensive search for an accessory pancreatic channel into the duodenum was without success. The pancreas and liver appeared normal in the gross. Microscopically the pancreas showed small areas of interstitial fibrosis and the liver revealed evidence of a very early biliary cirrhosis. Microscopic examination of the ampullar neoplasm disclosed adenocarcinoma arising in an area of papillomatous hyperplasia of the mucosa of the common duct at its orifice (Figs. 1 to 3).

From these findings, it was considered that both the bile and pancreatic secretions were evacuated into the fistulous tract of the operative wound. The marked dilatation of the ducts gave evidence of the resistance to the usual manner of flow and it was believed that the increasing pressure eventually ruptured the stump of the cystic duct.

This case illustrates the point mentioned that it may be quite a difficult problem to diagnose and treat correctly a complete pancreato-biliary fistula in which there is no erosion of the skin and nothing to suggest the vital loss of pancreatic secretion except the clinical syndrome if the latter is not recognized. It was felt at the time that the progressive decline without obvious cause represented some type of deficiency disease, most probably of the pancreas, and yet the absence of active trypsin in the fistulous fluid and the apparent lack of any similar clinical picture in the readily available literature left the nature of the condition undetermined until postmortem examination.

Yet, in retrospect and after an extensive survey of the experimental and clinical literature, we have failed to note any similar case in which this now understood syndrome was so clearly delineated and so analogous to the

deleterious and fatal effects produced by the total loss of pancreatic juice in experimental animals. The microscopic appearance of the pancreas bore a close resemblance to the changes described by Elman and McCaughan in their fistulous dogs.

The pathological lesion at the basis of the complete fistula in this case is rather uncommon, less than two hundred instances of carcinoma of the ampulla of Vater having been noted in the literature.

After witnessing the profoundly deleterious effects resulting from the total exclusion and loss of pancreatic secretion from the intestine one wonders how large a part the pancreas plays in those types of obstructive jaundice in which both the bile and pancreatic ducts are obstructed and these secretions fail to reach the intestine. Why is carcinoma of the pancreas and especially of the ampulla so rapidly fatal? As Upcott has well remarked, there is probably no portion within the human body outside of the central nervous system where a growth while yet so small is heralded by more widespread symptoms than at the lower end of the common bile duct. In over three fourths of the 110 cases of ampullar carcinoma collected by Outerbridge from the literature, the growth was limited to the papilla and its immediate surroundings death apparently occurring as a direct result of interference with the flow of the external secretions.

The rapid course with jaundice loss of weight and strength, and exhaustion death within a period of a month is so dominated by the obstructive jaundice that the obstruction to the pancreatic secretion is apt to be overlooked in explaining the quick exitus. The clinical picture is usually ascribed to the toxic effect of the bile (4) whereas the symptomatology with the exception of the jaundice points as much if not more to an insufficiency of the pancreas in these cases. This suggests to us that the latter factor may be the lethal one in carcinoma of the ampulla and pancreas and in other tumors and lesions in this region, which act so as to shut off completely from the intestine the pancreatic secretion as well as the biliary principle. Marked obstructive jaundice is frequently seen with little impairment to the general health, as in catarrhal jaundice



Fig. 3. Low power view showing the transition from papillomatous hyperplasia of the mucosa of the common duct (above) to frank adenocarcinoma (below).

and stone in the upper part of the common duct. Further investigations are certainly indicated in clearing up this important point.

TREATMENT

Space will not permit us to go fully into the treatment of pancreatic fistula, and we shall merely sketch some of the more current therapeutic procedures. Treatment may be conveniently classified into conservative, into which most cases fall, and radical, in which the fistula arises directly from Wirsung's duct in the head of the pancreas in which progressive emaciation and lack of response to conservative measures make operative interference imperative. Wohlgemuth's much quoted regimen consists in suppression of carbohydrate in the diet and the administration of alkali in high dosage, both of which were noted to decrease markedly the amount of pancreatic secretion in a case of fistula on which he carried out extensive therapeutic experiments. According to Pregl and also Kroiss, erepnone can be employed to advantage by mouth and enema, through which the defect in the diet may be remedied and carbohydrate added. Hartman and Santy have presented good results with atropine and bella donna, alone or associated with Wohlgemuth's diet. Fresh sheep's pancreas is said to be beneficial when fed in daily amounts of at least $\frac{1}{4}$ pound.

Schmilinsky in 1912 was the first to report the beneficial effect of feeding back fistula bile and intestinal juice from small intestinal fistulas. Gerster in this country came to a similar conclusion that the administration of bile in physiological amounts is a method for materially improving the condition of debilitated patients with common duct obstruction. Such feeding must be by stomach tube since the experience of Kausch shows that bile cannot be administered by mouth. Amelioration of symptoms by tube ingestion of fistulous pancreatic juice has also been reported by Cathala and Sénèque as noted above. The general treatment must always include parental administration of fluids, dextrose and chlorides as long as the toxæmia, starvation and excessive fluid loss by fistula and vomitus persist.

Local treatment has consisted of various astringents, curettage, dilatation, suction, pump drainage and roentgenotherapy. Potter claims striking success by paddling the crater of the wound in gauze soaked in bovinum and feeding 1/10 normal hydrochloric acid to the fistula by a medicine dropper or Murphy drip.

Operative procedures are either designed to extirpate the fistulous tract if fistula is incomplete or to anastomose the pancreas or the tract to a hollow viscus usually the stomach or duodenum. Successful results have been reported with all these types of operations, some of which have been performed as a sequel to a first stage extirpation of a tumor of the ampulla of Vater such as was present in this case.

SUMMARY

1. It is suggested that complete exclusion of pancreatic juice from the intestine with loss by external fistula produces a highly characteristic clinical syndrome consisting of striking anorexia, nausea, intermittent vomiting, steatorrhea, extreme exhaustion, anhydremia, and emaciation with lethal termination.

2. A clinical example of this symptom-complex is presented, corresponding in all important respects with the deleterious and fatal effects of complete pancreatic fistula in experimental animals.

3. The necessity for totality of the fistula in producing the complete syndrome is

stressed, presupposing in every instance a complete obstruction of Wirsung's duct and an absence or obstruction of accessory duct openings into the intestine hence the rarity of the condition. It appears that partial or incomplete pancreatic fistula may in certain instances be associated with such symptoms as anorexia, weakness, loss of weight, and steatorrhea.

4. Concomitant biliary principle and absence of trypsin or erosive properties in the fistulous fluid may readily lead to errors in diagnosis.

5. The question is raised as to whether the exclusion of pancreatic juice from the intestine in some types of complete obstructive jaundice may not be the major factor in the rapidly fatal outcome as for example in carcinoma of the ampulla of Vater and carcinoma of the pancreas.

6. A short résumé of the more accepted methods of treatment in pancreatic fistula is presented.

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THE VALUE OF ESTIMATIONS OF THE AMYLASE OF THE BLOOD IN THE DIAGNOSIS OF SUSPECTED PANCREATIC DISEASE

AN EXPERIMENTAL STUDY AND REVIEW OF THE LITERATURE

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THE incidence of disease of the pancreas is probably greater than is generally supposed. Mayo-Robson and Cammidge (1907) Moench (1924) and Barron (1925) noted an incidence of slightly more than 2 per cent of lesions affecting the pancreas. Elman, Arneson and Graham (1929) found lesions of the pancreas to the extent of 3 per cent in 3,600 necropsies and in the records of 69,000 patients in hospital found an incidence of 0.25 per cent with a diagnosis of pancreatic disease of some type exclusive of diabetes mellitus. Mayo-Robson and Cammidge state that many lesions of the pancreas go unrecognized the chief reasons being the absence of a syndrome pathognomonic of pancreatic disease, the inaccessibility to palpitory diagnosis and roentgenography the lack of a reliable test of function, and finally the rapid autolysis in the pancreas after death.

McWhorter studied 64 case reports of acute pancreatic necrosis by members of the Chicago Surgical Society and found that the correct diagnosis was made only eight times or 12.5 per cent. The diagnosis was entirely incorrect in 48 cases or 75 per cent. A definitely lower mortality was noted in the cases in which operation was performed immediately as compared with those cases in which operation was performed late. McWhorter states. Considerable progress has been made through experimental study and by more general clinical recognition of acute pancreatitis, but owing to its infrequent occurrence and to the relatively difficult diagnosis, little progress has been made in reducing the incidence or in lowering the mortality of this highly fatal condition.

Schmieden and Sebening reported 2137 cases of pancreatic affections of various kinds. In the group with acute pancreatic necrosis, a positive diagnosis was made in only 21.8 per cent of the cases and suspected in 17.5 per cent. These authors likewise state 'In con-

trast to the rarer general picture of acute pancreatitis there is still lacking a modern aid for making the exact diagnosis in the numerous atypical cases. Even today we must manage without a pathognomonic test which would make the diagnosis positive.'

In practice the diagnosis of pancreatic affections of surgical interest depends almost entirely on physical signs and symptoms which though fairly characteristic, may readily be confused with other intra abdominal conditions. Laboratory methods for the detection of disturbances in the function of the pancreas though numerous in the literature have unfortunately been little used in actual practice. Tests for disturbances in the physiology of the pancreas with few exceptions are based upon an investigation of the function of the pancreas with respect to the activity of its enzymes. It is unfortunate that special works on the diagnosis of disease by laboratory methods place too much emphasis on tests of pancreatic function which have been abandoned or which have been shown to possess but little value. The principle, however of investigating the function of the pancreas by a study of the blood for evidence of an abnormal concentration in its enzyme content, as an indirect index to coincidental pathological changes, is apparently sound but the method should be quantitative rather than qualitative. Such tests when applied to the feces, the urine or the gastric or duodenal content are more difficult of control and therefore, less significant than when applied to the blood.

THE BLOOD AMYLASE. A REVIEW OF THE LITERATURE

In 1803 Payen and Persoz precipitated a starch splitting substance from malt and gave it the name of diastase. The diastatic activity of the blood was observed first by Magendie in 1846 who showed that the blood was

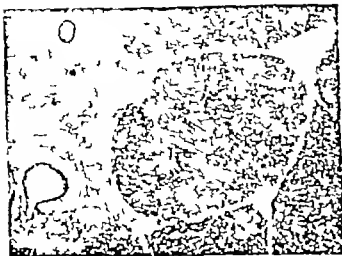


Fig. 1. Low power photomicrograph of pancreas after total occlusion of pancreatic ducts. Shows degree of interacinar and interlobular fibrosis, atrophy of acini and dilatation of ducts with periductal fibrosis.



Fig. 2. Low power photomicrograph of pancreas after experimental ligation. Shows degree of hemorrhage and lobular stroma.

capable of splitting starch into sugars. Foster first measured diastase quantitatively in animal organisms in 1867. The next most important contribution to the subject was that by Wohlgemuth (49) who in 1908 described an improved quantitative method for the determination of amylase. Following Wohlgemuth's work, various other quantitative methods were described, most of which depended on the ability of amylase to effect a given change on a known solution of starch. Northrop and Hussey conceived the idea of measuring the viscosity of solutions containing enzymes (trypsin) during the period of action of the enzymes. They found that the change in the initial viscosity of the substance was inversely proportional to the amount of enzyme. Davison employed the technique of Northrop and Hussey to determine diastatic activity, using instead of a 3 per cent gelatin solution a boiled autoclaved buffered solution of starch two and one-half times more viscous than water and obtained for diastase results similar to those which were obtained by Northrop and Hussey for trypsin and pepsin. Maslow and Davison compared the viscometric with other accepted methods such as the iodometric, the copper reduction and the polariscopic methods for determination of the activity of diastase and found that the results were similar.

Carlson and Luckhardt called attention to

the fact that in their concentration in their concentration in serum having a concentration in cerebrospinal fluid the conclusion was that amylase was a general tissue constituent. Beddard found amylase in livers, muscles and depancreated livers to ascertain whether or less than 100 units of blood after 24 hours. Schlesinger found amylase in the pancreas after 24 hours of observation. Ross who found amylase in the pancreas of the cat. Constant found amylase in the diastases of the pancreas of the cat. Schlesinger found amylase in the glands of the blood. General amylase in the blood. (41, 7) Takami.



Fig. 3. Low power photomicrograph of pancreas after injection of the larger pancreatic duct with a 3 cubic centimeter suspension *Bacillus coli* shows intramural edema and infiltration with polymorphonuclear leucocytes and round cells. There is some distention of the mucosal lining and a considerable amount of cellular debris within the lumen of the duct. The acini appear fairly normal.

diastatic ferment in the cerebrospinal fluid following ligation of the pancreatic duct. In experimental injuries to the pancreas, increase in the urinary diastase was noted by Wohlgemuth and Noguchi (52). Of particular interest is an observation by Wohlgemuth (50) that ligation and division of the common bile duct in a series of dogs caused a delayed but considerable secondary rise in the diastatic activity of the blood and urine and a simultaneous fall in the diastase content of the feces. This did not occur however if the upper pancreatic duct was ligated and sufficient time allowed for a stabilization of the diastase concentration of the blood before ligation and division of the common bile duct was performed.

Elman and McCaughan (16) using the viscosimetric method made quantitative determinations of the amylase in the blood of normal dogs. They observed that the amylase of the blood was comparatively uniform in normal animals and that fasting and meals did not seem to have any influence. Ligation of the pancreatic ducts caused marked increases in the amylase content of the blood. In three animals with total external pancreatic fistulae they showed that the intestinal absorption of diastase was insignificant in maintaining the level of the enzyme in the blood. Henning



Fig. 4. Low power photomicrograph of pancreas after injection of 15 cubic centimeters bile with rupture of the major pancreatic duct system shows an acute pancreatic necrosis with occasional islands of intact acinar cells.

and Bach have confirmed this latter result for human beings. Johnson and Wies likewise obtained rises of several hundred per cent in the serum amylase after ligation of the ducts. The level was sustained for variable periods of time usually for 5 to 12 days followed by a decline to within 100 per cent of the preoperative level. No variation in controls was observed where the pancreas was merely exposed. Histologically they found atrophy of the acinar tissue but the islets were unchanged.

Extensive investigations of the blood amylase in disease have been made. Wohlgemuth (51) reported considerable fluctuation in the amylase concentration of the blood and urine in health but noted marked increases in acute conditions affecting the pancreas. Similar observations have been made by others (20, 25, 29, 39, 24, 39, 42). Bentzen reported marked increases in nephritis but also found considerable variations in the diastase concentration in both blood and urine in normal individuals. The values for blood amylase in normal persons according to many other investigators however are fairly constant and unaffected by diet (23, 32, 9, 45, 8, 40). Myers and Killian, using a copper reduction method found increased diastatic activity of the blood in both diabetes and nephritis. They were unable to offer a satisfactory explanation for the former condition although the latter they stated undoubtedly depends on a decreased excretion of the diastase.

Stocks found an increase in blood amylase in the presence of carcinoma of the pancreas, nephritis and chronic passive congestion and in some cases of diabetes mellitus. Arneson and Morrin found that pregnancy had no effect on the blood amylase, but that a slight rise was noted in difficult or prolonged labors. In toxemias with hypertension blood amylase values were below normal. They found as many as 40% that urine varies too much for satisfactory estimation.

Somogyi was led to develop another method of studying blood diastase because of the conflicting conclusions in the literature. In healthy humans he found four fifths of the diastase in the plasma and only one fifth in the corpuscles. He noted that the normal diastase content of the blood displayed variations of as much as 100 per cent. In toxic conditions it usually was greatly diminished. Tureen used Somogyi's method in the study of blood diastase in cancer and concluded that as a diagnostic test of cancer, the determination of amylase in the blood was not significant.

Elman (13) studied the blood amylase in pancreatic disease using the viscosimetric method. In 5 patients with pancreatic diseases variations from the normal value were encountered. In 30 patients suffering from other diseases the blood amylase was within normal limits. The value of amylase determinations in the blood in subacute and in chronic pancreatic diseases was studied by Wakefield, McCaughan and McVicar also using the viscosimetric method. In a group of 20 patients known to have pancreatic tumors the values for amylase in the blood were increased in 6 and normal in 14. In a group of 30 patients suffering from various other diseases the values for amylase in the blood were increased in 2 cases. These authors concluded that the percentage of positive results seemed too small to warrant the adoption of a routine diagnostic procedure of study of the amylase of the blood in cases of suspected pancreatic disease. McCaughan (47) obtained experimental data on the dog which suggested that the value of the study of blood amylase as a diagnostic test in pancreatic disease is largely limited by con-

sideration of the time factor. Elman, Arneson and Graham (15) determined the concentration of amylase in the plasma in 60 adult humans. They believed that they could demonstrate a definite correlation between concentration of blood amylase and the presence or absence of disease in the pancreas, and stated that this supported the experimental evidence that this ferment in the blood is largely of pancreatic origin. Elman (14) collected 20 more cases in which blood amylase was studied. The findings, he stated, indicated that a normal blood amylase was found when the acini of the gland were normal and that deviations from this normal value in the nature either of increases or decreases were noted when the acini or ducts were diseased.

While many other investigators have observed the amylase of the blood of human beings and lower animals, both in health and in disease, the results are far from uniform. Differences in method and the variety of measuring units make satisfactory interpretation of the data of various observers difficult. Nevertheless, it seems generally accepted that the blood amylase is fairly constant under normal conditions and significant variations do occur in the presence of disease of the pancreas. The apparent divergence of opinion as to the clinical value of routine determination of blood amylase in the diagnosis of disease of the pancreas led to the present experimental investigation.

EXPERIMENTAL PROCEDURE

Blood amylase determinations were made on samples of oxalated dog plasma with viscosimeters of the Ostwald pattern as the substrate a specially buffered and autoclaved solution of starch prepared according to the method of Lintner (Merck) being used. The technique followed was essentially that described in 1927 by Elman and McCaughan and used since with slight modification by Elman and his coworkers and by Wakefield, McCaughan and McVicar. Healthy dogs of either sex and of approximately similar weight were chosen. They were kept in clean, well ventilated cages and fed a uniform diet consisting of Pratt's dog biscuits and as much

water as desired. The various operative procedures are described below. These were carried out under ether anesthesia, and a strictly aseptic surgical technique was employed in every instance. The following groups of experiments which consisted of attempts to reproduce, as nearly as possible, pathological affections of the pancreas encountered in clinical surgery were performed:

1. A control group (a) in which the abdomen was merely opened the pancreas gently handled and its ducts exposed after which the abdomen was immediately closed (b) in which the major pancreatic duct was exposed and injected with a sterile solution of physiologic saline.

2. A group in which ligations of one or both of the pancreatic ducts were done. The technique consisted in doubly ligating the duct and dividing it between the ligatures. Oriental tags were tucked between the proximal and distal ends of the duct to prevent possible reunion and accessory ducts were carefully searched for in each instance. This group may be subdivided into (a) occlusion of both major and minor pancreatic ducts (b) occlusion of major pancreatic duct alone and (c) occlusions of minor pancreatic duct alone. This group was intended to demonstrate the possible effects of ductal obstruction clinically as, for example, by stone stricture inflammation cyst, or tumor on the concentration of the blood amylase.

3. A group in which varying degrees of experimental trauma, simulating pancreatic injury clinically were produced.

4. A group in which the pancreas was totally extirpated. In these experiments the motive was twofold: first it seemed desirable to perform pancreatectomy in order to study the general behavior of the blood diastase following its total removal and to compare our results with the observations of Milne and Peters, Schlesinger and Davis and Ross and, second, because of the interest which has been aroused by the occasional observation of very low values for blood amylase in patients with extensive malignant infiltration of the pancreas.

5. A group in which various chemical and bacterial irritants were injected into the pan-

creatic ducts without ligation of the duct following injection and at injection pressures both below and above that required for the injected fluid to rupture the walls of the duct and enter the parenchymal substance of the gland. This group was intended to demonstrate the effects of varying degrees of pancreatitis on the concentration of the blood amylase.

Samples of blood were taken before operation and again at frequent intervals after ward, and an estimate of the amylase concentration was promptly made. At the end of each experiment the animal was killed unless death had supervened earlier and a careful necropsy examination was performed. The pancreas was removed and sectioned transversely at four points equidistant along the longitudinal axis of the gland. These sections were stained with hemotoxylin and eosin and an attempt was made to correlate the anatomical changes with the variations in the curves of the blood amylase.

Results: The following protocols represent typical experiments.

Experiment 1: On January 14, the abdomen of a female dog weighing 12 kilograms was opened and the pancreas gently handled. The major pancreatic duct was exposed in the same manner as in operations for the ligation or injection of the duct and the abdomen was then immediately closed. Thirty-eight days after operation total pancreatectomy was done. The pancreas was grossly and microscopically normal. The blood amylase for the period of observation is shown in Chart I, Curve 1.

Gentle manipulation of the pancreas during laparotomy produced no change in the level of the blood amylase.

Experiment 2: On January 3, the minor pancreatic duct of a male dog weighing 11 kilograms was doubly ligated and divided. The condition of the animal after operation was excellent. On the fifty-seventh day after operation, the dog was killed under ether and the pancreas removed for study. Grossly and microscopically the gland appeared normal except for slight increase in the connective tissue of the supporting stroma in the cephalic limb. Chart I, Curve 2.

The least rise in the level of the blood amylase and the smallest degree of pathological change was encountered in ligations of the

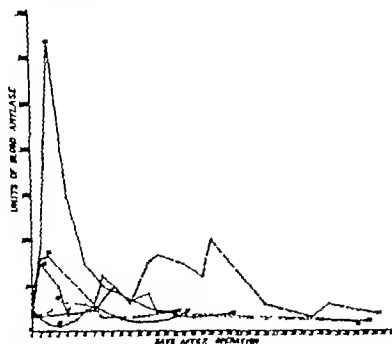


Chart I. Curve 1 control laparotomy—pancreas gently handled and ducts exposed. Curve 2 minor pancreatic duct divided between ligatures. Curve 3 major pancreatic duct divided between ligatures. Curve 4 major and minor ducts divided between ligatures. Curve 5 experimental trauma (crushing with forceps). Curve 6, total pancreatectomy.

smaller upper duct. Apparently the number of acini affected by its occlusion is not great or perhaps adequate anastomoses with the larger lower duct exist whereby the dammed up juice can find its way to the duodenum. The evidence here however, emphasizes the value of the test since even minor disturbances are readily demonstrable if the blood be examined shortly after the onset of the obstruction.

Experiment 3. On December 14 the major pancreatic duct of a female dog weighing 11 kilograms was divided between ligatures. Her condition throughout was excellent. Postmortem examination on the thirty-eighth day after the operation showed the pancreas grossly normal but on microscopic examination there was a moderate degree of interlobular and interacinar fibrosis and some atrophy of the acini in the region of the head with slight distention of the ducts. Chart I, Curve 3 shows the variations in blood amylase.

Here a somewhat greater rise occurred than in the preceding experiment. The maximum height was attained within the first 48 hours and fell thereafter gradually toward the preoperative level. This was a common observation in the majority of experiments.

This particular experiment was of interest because of the secondary rises in the curve of the blood diastase a result which occurred several times in our experiments. This finding will be discussed at length further on.

Experiment 4. On December 14 both pancreatic ducts of a male dog weighing 8 kilograms were divided between ligatures. Following this procedure there was gradual loss of weight and strength. Stools characteristic of pancreatic insufficiency were noted. Twenty-eight days after operation the animal was killed with ether and the pancreas removed for study. In the gross the gland was atrophic, firm and markedly sclerosed. The microscopic picture in all of the sections was that of a well advanced interlobular and interacinar fibrosis with atrophy and degeneration of many acini. In sections from the region of the head of the pancreas, the ducts appeared greatly distended and there was considerable fibrosis of their walls. The islets of Langerhans appeared normal. Chart I, Curve 4, shows the variation in the blood amylase, and Figure 1 is a photomicrograph of a typical section of the pancreas.

As might be expected the greatest rise in the blood amylase occurred when the outflow of pancreatic juice was wholly prevented by the ligation of both upper and lower ducts. Obstruction to either the major or minor

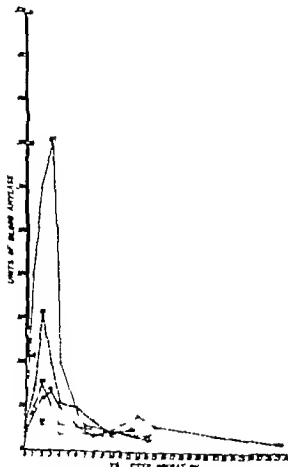


Chart II Curve 1 control injection of greater pancreatic duct with 5 cubic centimeters of sterile saline. Curve 2 injection of major pancreatic duct with 5 cubic centimeters of gastric juice. Curve 3 injection of major pancreatic duct with 5 cubic centimeters of bile. Curve 4 injection of major pancreatic duct with 5 cubic centimeters suspension of bacillus coli. Curve 5 control injection of 15 cubic centimeters of sterile physiologic saline with rupture of major duct system. Curve 6 injection of 5 cubic centimeters of bile with rupture of major duct system.

duct was followed invariably by a lesser degree of elevation of the diastatic concentration of the plasma. The intensity of the pathological changes in the pancreas could be readily correlated with the degree of rise in the level of the blood amylase. Figure 1 is typical of the sclerotic and atrophic changes produced by ligation of both ducts the effects in experiments in which only one of the ducts was obstructed differed only in being of lesser degree. This group of occlusion experiments indicates the diagnostic value of such ob-

servation in human beings when disease of the pancreas is suspected. Calculous, cicatricial or inflammatory obstructions of the ducts as well as those obstructions arising from compression by tumors and cysts can hardly be differentiated by such studies but the inference may be drawn that a lesion of the pancreas is present, provided the patient is seen early enough. In general however such conditions as enumerated above run a chronic course and are less likely to yield positive results on examination.

Experiment 5. On November 24 the caudal limb of the pancreas of a female dog weighing 8 kilograms was brought out through a small upper right rectus incision and severely crushed with an eight inch Ochsner hemostatic forceps, at one point near the major duct the jaws of the forceps were applied to the transverse diameter of the gland several times. There was considerable bleeding within the parenchyma and beneath the peritoneal investment of the pancreas and at several places the pancreas was severely lacerated. The animal remained in excellent condition and 14 days after operation was killed with ether and the pancreas removed for study. Grossly the pancreas appeared normal except for signs of old hemorrhages beneath the peritoneal covering. Microscopically the principal lesion was a hemorrhage into the interacinar and interlobular spaces with here and there areas showing atrophy or degeneration of acini. Chart I Curve 5 shows the variation in blood amylase and Figure 2 is a photomicrograph of a typical section of this pancreas.

Trauma to the human pancreas, because of its protected location is a rare occurrence but evidence of pancreatic injury may readily be demonstrated from a study of the blood amylase.

Experiment 6. On March 20, a total pancreatectomy was done on a male dog weighing 15 kilograms. After 5 days, asthenia, polydipsia, polyuria and loss of weight were evident. The blood sugar by the Folin method ranged from 230 milligrams per 100 cubic centimeters of blood on the second day after operation to 300 milligrams per 100 cubic centimeters of blood on the sixth day after operation. The pancreas was grossly and microscopically normal in appearance. Chart I Curve 6 shows the variation in the blood amylase.

Total extirpation of the pancreas causes a rapid fall in the diastatic activity of the blood. This decrease in the amylase concentration however is of comparatively short duration and the concentration of the enzyme soon re-

turns to the pre-operative level. This observation would seem to cast some doubt upon the explanations given for the low value of blood diastase reported in patients with carcinoma of the pancreas. Further investigations into the source of blood diastase and into the mechanism by which its concentration in the blood is controlled are desirable.

Experiment 7 On December 5 the major pancreatic duct of a male dog weighing 7 kilograms was injected with 5 cubic centimeters of a sterile solution of physiological saline. The subsequent course was uneventful. Chart II Curve 1 shows the variation in the blood amylase. The pancreas was examined at post mortem 14 days later and found to be grossly and microscopically normal.

The slight rise in the curve of the daily blood diastase concentration noted here may perhaps have been caused by the experimental procedure, but such a slight difference in levels of diastase is within the normal range of variability.

Experiment 8 On March 6 5 cubic centimeters of gastric juice was slowly injected into the major pancreatic duct of a male dog weighing 10 kilograms. There was an immediate change in the region of the injected duct from the normal pink appearance of the parenchymal surface to a deep grayish red discoloration. The animal apparently suffered no ill effects from the injection and on the thirty second day after operation he was killed under ether and the pancreas removed for study. Grossly there was a moderate degree of atrophy and fibrosis and microscopically the chief lesions were a periductal and periductal infiltration of round cells and polymorphonuclear leucocytes. Chart II Curve 2 shows the variation in the blood diastase for the period of observation.

The injection of 5 cubic centimeters of gastric juice slowly at low pressure was without effect on the general health of the animal. A prompt rise in blood amylase was the only apparent abnormal reaction to this insult.

The sections from the pancreas at post mortem revealed definite lesions.

Experiment 9 On February 23 5 cubic centimeters of dog bile was slowly injected into the major pancreatic duct of a male dog weighing 9 kilograms. There was no immediate change in the gross appearance of the gland following injection. Sixteen days after an apparently uneventful course, the animal was killed under ether and the pancreas removed for examination. Grossly the gland appeared fairly normal but microscopically the larger ducts in the

region of the head were somewhat distended. There was considerable newly formed fibrous tissue and a moderate degree of round cell infiltration in their walls but the mucosal lining appeared normal. Chart II Curve 3 shows the variation in blood amylase.

The injection of a small quantity of bile at low pressure had no apparent effect on the general health of the animal. A study of the blood, however, reveals an abnormal rise in the blood amylase and examination of the sections of the pancreas of this animal shows clearly the presence of definite pathological changes.

Experiment 10 On April 10 5 cubic centimeters of a virulent culture of *Bacillus coli* was injected into the major pancreatic duct of a male dog weighing 9 kilograms. The animal reacted normally in every way and on the seventh day after operation was killed with ether. The pancreas grossly appeared normal but histologically there was distention of the ducts with much newly formed fibrous tissue in the walls and a marked infiltration of round cells and polymorphonuclear leucocytes. There was some desquamation of the ductal mucosa and, in many instances, the lumina contained considerable amounts of leucocytes and cellular debris. Chart II Curve 4 shows the variation in the blood amylase throughout the period.

The injection into the pancreatic duct of suspensions of virulent bacteria without rupturing the duct produced greater rises in blood amylase than occurred in any of the preceding experiments. While there was nothing abnormal in the subsequent behavior of any of these animals it was quite evident from examination of the pancreas microscopically later that definite lesions had been produced. We believe that the evidence indicates that the rise in the concentration of the amylase of the blood is directly due to the effects of experimentation on the pancreas.

Experiment 11 On April 27 15 cubic centimeters of a sterile solution of physiologic saline was injected into the major pancreatic duct of a male dog weighing 7 kilograms. The postoperative course was uneventful. On the fifteenth day following the operation, the animal was killed with ether and the pancreas removed for examination. It was grossly and microscopically normal. Chart II Curve 5 shows the variation in blood diastase.

The injection of 15 cubic centimeters of physiologic saline under sufficient pressure to

rupture the ducts produced a moderate rise in blood diastase but microscopic examination of sections of the pancreas subsequently revealed no definite evidence of injury

Experiment 12 On November 18, the major pancreatic duct of a male dog of 10 kilograms was injected with 15 cubic centimeters of bile under sufficient pressure to break through the ducts and force the fluid out into the parenchymal substance. The pancreas quickly became swollen and stained deeply with bile. The animal died early the following morning and at postmortem examination there was considerable thin sanguineous exudate in the peritoneal cavity and a markedly swollen, bile-stained, hemorrhagic pancreatic gland. There were many areas of fat necrosis in the omentum. The major pancreatic duct was probed and found patent. The sections microscopically showed a widespread destruction of all units of the histological structure. Figure 4 is a photomicrograph of a typical area and Chart II Curve 6 shows the variations in the blood amylase

Acute pancreatic necrosis may readily be produced experimentally by the injection of the pancreatic ducts with a larger quantity of fluid and at a pressure great enough to rupture the terminal end chambers of the ducts and thus force the material within the substance of the gland. The course from then on is fulminating and the blood amylase within a very short time increases tremendously. The value of blood diastase determinations in the differential diagnosis of acute abdominal disorders is ably demonstrated in this experiment

RECAPITULATION

While it is not our purpose to evaluate various methods for the determination of the diastatic activity of the blood the method used here is probably as satisfactory as any for routine clinical work. We have had no experience with the method recently described by Somogyi but feel that his criticism of one aspect of our method is valid. We too have had the same experience with the difficulty of preparing exactly similar solutions from different batches of starch this objection in our experience however has not been important

In a series of 15 apparently healthy animals, the amylase of the blood averaged 20.6 units, the lowest reading obtained was 15 units and the highest was 44.4 units.

In experimental pancreatic disease, variations in the level of blood amylase occur with regularity in dogs and definite lesions are readily found subsequently within that organ. On the basis of these experiments, however it must be admitted that for practical clinical purposes the value of the study of blood diastase is largely limited by the length of time which has elapsed since the onset of the disease. Experiments which result in obstruction to the outflow of pancreatic juice and experiments which occasion varying degrees of pancreatitis, show rises in blood diastase values above normal within a few hours. The height of the rise seems to be directly proportional to the degree of occlusion of the pancreatic ducts or to the extent of parenchyma involved in inflammatory processes. The maximum rise in complete duct ligation experiments is reached within 72 hours and the curve of increased amylolytic activity is sustained usually for not more than 8 to 15 days. In a few experiments (3 and 5 Chart I Curves 3 and 5) secondary rises in amylolytic activity took place after the primary fall had occurred. De Takats and Nathanson made a similar observation during their work on the correlation of the internal and external pancreatic secretions. Using the Wohlgemuth method they noted an early rise in blood diastase after isolation or ligation of the tail of the pancreas followed by a secondary rise about the seventh day. They make the interesting suggestion that this secondary rise is due to the disappearance of the initial edema

While the essential function of the amylase in the various tissues and fluids of the body is not well understood the mechanism by which increases in the normal content of the amylase of the blood plasma occurs seems fairly clear. Obstruction of the ducts of the pancreas leads quickly to an overdistention of the ductal system the back pressure thus caused soon results in atrophy and degeneration of the secreting units, the acini and further secretion stops before this stage is reached however a reabsorption of the diastatic ferment into the blood stream takes place and its concentration there is greatly increased. The ferment soon appears in increased amount in

the urine and there is a greatly diminished or total absence of diastase in the feces. Gradually, however, the blood diastase returns to normal concentrations and this recession probably parallels the processes of atrophy and degeneration taking place within the acini of the pancreas. Inflammatory processes also result in abnormally high values possibly in very much the same way. The inflammatory swelling of the acini and the lining of the ducts is no doubt responsible for the enzymes being passed back into the blood stream and increasing the concentration there far beyond normal. In acute pancreatic necrosis the sudden and extreme elevation in blood amylase is possibly due to the rapid extensive cellular destruction which occurs. The liberated ferments are quickly taken up by the blood and may be found there in great concentration within a few minutes after injection.

Wohlgemuth, and Polacco and Midana have shown for the salivary glands, that obstruction of Stenson's ducts results in increased diastatic activity of the blood and urine. The salivary glands should be more thoroughly investigated in conjunction with the pancreas. That the pancreas is not the main source of starch splitting ferments in the blood, is shown by the fact that after total pancreatectomy the blood amylase falls to approximately 20 per cent of the pre-operative level (Chart I, Curve 6) but very quickly starts back to normal. This return to normal after pancreatectomy occurs in about the same length of time as noted for those experiments resulting in greatly increased concentrations of blood diastase. The reason for this rapid fall in diastase and subsequent return to normal after pancreatectomy is not clear. More study is needed to throw light on the primary source of blood amylase.

In control experiments, gentle manipulations of the pancreas or the injection of 5 cubic centimeters of sterile physiological saline causes no significant variation in the amylase content of the blood. The injection of physiologic saline in amounts of 15 cubic centimeters or more with pressure enough to rupture the ducts caused a moderate rise in blood diastase. This probably is due to mild trauma, as noted by Opie.

Traumatizing the pancreas mechanically also gave rise to a moderate elevation in blood amylase but caused little disturbance in the general health of the animal.

Baló and Ballon studied the effect on the pancreas of obstruction to its ducts. Their observations indicate that acute or chronic retention of pancreatic secretion brings about histological changes consisting of a dilatation of the ducts and end chambers and a flattening of the cells in the glands. Necrosis may then follow and a lipomatosis sometimes results from fat replacement in the necrotic areas. These investigators also believe that an increase in the size of the islands of Langerhans may take place. McWhorter, in a recent review of experimental pancreatitis notes considerable disagreement among investigators with regard to the readiness with which fatal pancreatitis can be produced. In these investigations, however, the production of acute pancreatitis in the dog experimentally by the injection of bile gastric juice or virulent bacteria was readily accomplished when care was taken to rupture the pancreatic ducts during injection but if this was not done the effects were mild both clinically and pathologically. The lesions noted in some of our experiments, moreover, are similar to those reported by Johnson and Wies and de Takats. They consist primarily in degenerative changes in the acini and fibrous tissue replacement. Ductal changes pictured by Baló and Ballon were also noted. The islets generally were unaffected. Correlation of the pathological findings with the curves of the blood amylase indicates a direct relationship between the height and the duration of sustentation of the curves, and the extent and intensity of the lesions.

CONCLUSION

The normal range of the blood amylase is fairly narrow and is little affected by ordinary conditions of life. Estimations of the blood amylase in suspected pancreatic disease may be of the greatest value, for if increased or diminished concentrations of blood amylase are found involvement of the pancreas is greatly indicated. The observations, however, must be made during the comparatively

brief period (8 to 15 days) of abnormal blood concentration otherwise blood amylase values again within the normal range are likely to be encountered. In patients with chronic pancreatitis, pancreatic tumors, cysts and ductal obstructions of various kinds it would seem therefore that many negative results must be expected. Thus the clinical value of the test as a routine will probably not be great except in the few cases seen early by the clinician at the onset of the disease and examined promptly for evidence of abnormal variations in the blood amylase. The technique is simple and the determinations can be made quickly by anyone familiar with the method. This consideration and the fact that a high incidence of positive results may be expected in acute conditions involving the pancreas and that this information would be of infinite value to the surgeon should recommend this test especially in such cases.

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PRE-OPERATIVE PREPARATION OF THE PERITONEUM IN SURGERY OF THE LARGE INTESTINE

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AS the details of the technique of various surgical procedures in the abdomen have become more and more standardized greater attention has been focused on other factors tending to increase the safety of the operative work. The chief factor in the mortality following operations on the large intestine has been postoperative peritonitis. As we look at the problem as a whole this postoperative peritonitis is due to one of three causes:

- 1 Soiling of the peritoneum at the time of operation because of poor technique

- 2 Soiling of the peritoneum from a late leak in the suture line. This may be due to poor technique but is more likely to be due to poor pre-operative preparation so that the tissue is in poor condition from edema. The bowels themselves are in poor condition so that there is abnormal gas pressure after operation and the combination results in poor healing and leakage.

- 3 A lack of immunity in the peritoneum to a slight infection which, under more favorable circumstances, it should be able to handle.

The first danger has been lessened by the various forms of mechanical apparatus which aid in resections as, for instance, the Rankin clamp and our own intestinal anastomosis clamp (13). The second danger has been lessened by all those measures which improve the condition of the bowel and tend to restore the normal chemistry of the body. The third factor has only recently been studied in an attempt to meet the problem from a practical standpoint.

It has long been recognized that the peritoneum will react to various sterile substances in a manner that is not entirely understood and up to the present has been very little studied. The ability of the peritoneum to absorb solutions has been made use of par-

ticularly in children for the intraperitoneal injection of fluids and for medication. The intraperitoneal use of diphtheria antitoxin has been recognized the amount of reaction apparently depends on the type of antitoxin used. Where the whole serum was used there was a marked reaction in 66 per cent of the cases as against 12 per cent where the refined antitoxin was used (7). The peritoneal cavity has also been used for the administration of neo-arphenamine without harmful effects or damage to the peritoneum (10). Nevertheless as with every foreign substance there are reactions in certain cases which are so severe that, at least in experimental animals, a considerable exudate and some later organization have often been demonstrated. Our knowledge of the reaction of the peritoneum to various substances has come because of the need of using this pathway for the introduction of substances either fluid or drugs into the body. Consequently no other extensive studies of what happens in the peritoneum itself have been made.

Four years ago Rankin and Barger (8, 9) first published the results of their attempts to immunize the peritoneum by the use of vaccines prepared from streptococcus and colon bacillus recovered from fatal cases of peritonitis. Injections were given intraperitoneally on two occasions before operation with a considerable degree of reaction but with such satisfactory results that the discomfort seemed to be more than overbalanced. They reported a reduction in mortality from 23 per cent to 5 per cent. On the basis of these figures as given, it seems reasonably clear that a local immunity had been produced.

When we use the word "immunity" we are talking about something the exact nature of which is not understood, certainly not completely. What we actually know about is the result of the process which ends in immunity, and that is the resistance either of the body as a whole or of certain tissues to infection when

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exposed. We have been taught that immunity may be either natural or acquired. Probably all immunity is acquired, although the process in some instances takes place without knowledge or upset to the individual just as it is suggested at present that the so called natural immunity to infantile paralysis may actually be an acquired immunity from an early mild form of the disease too little bothersome to be noticed. As an example of local immunity, we know that in a case of destructive sepsis in a finger where so much damage has been done that amputation is necessary the safest time to do it is not after the healing has been completed, but before this has taken place when there are certainly some organisms present. To go more directly to the tissue we are discussing it is a well accepted fact that in a gall bladder operation following soon after a subacute cholecystitis pus from the gall bladder may be spilled into the peritoneum with comparative immunity. Also, in the face of an old fecal fistula the danger of peritonitis is very much lessened if any operation in the peritoneal cavity has to be undertaken. This is even true after a temporary colostomy has been done to relieve an acute obstruction. The secondary operation necessary to resect a carcinoma has been made much safer because of it.

Also in considering this question of immunity certain isolated facts have come to mind which, when put in their proper place, must make us feel more and more strongly that the question of the receptivity of the tissue may be as important as the presence or absence of a small amount of infection. For instance a few years ago we became interested on the East Surgical Service at the Massachusetts General Hospital in the possibility of infection coming from the inside of a glove turn toward the end of an operation. The bacteriologist at that time was considerably interested and for over 4 months the inside of all of the gloves of the whole surgical team were carefully cultured and it was found that the one man who put the gloves on wet in 71 per cent alcohol would show the occasional culture of a *Staphylococcus aureus*, streptococcus, or some other organisms as often as

the men who used dry gloves. It was found that the house officer in charge of the septic ward was no more likely to have organisms on his hands than anyone else. It was also demonstrated that in none of the cases in which organisms were grown did there happen to be any postoperative sepsis. Recently Hunt has agitated the question of air born infections and he and others have demonstrated a growth of various potentially virulent organisms on a Petri dish reposing near the open abdominal wound but again no connection between this and fatal infection has developed. In other words the tissue must be prepared to receive them. This whole problem has been well brought out by Cabot in his article called 'The Doctrine of the Prepared Soil.'

We must recognize here that factors other than immunity *per se* come into the question because of course the bowel above the obstruction has been made more normal and the bacteria present rendered less virile by the other measures used. The tissue has been improved in general condition by relieving congestion and edema and the chemical balance of the patient has been restored but certainly no one can deny that the peritoneal irritation which has taken place and the slight peritonitis which has also accompanied the colostomy has added the indefinite something which increases the factor which we call local immunity. In view of all these problems involved in the question of immunity it is certainly reasonable to employ all the known methods which can be demonstrated to be safe and which may have an effect in lessening the danger of peritonitis in those operations where it is the commonest cause of mortality. Because of the complicated nature of the process we call immunity, it seemed to us that there might be some doubt whether the reaction which came from the use of the vaccine as used by Rankin and Bagen was actually a specific immunization or whether it was in fact merely the response of the peritoneum to an insult represented by the introduction of a foreign protein and whether the same benefits might not come from the same reaction induced with a less marked upset to the patient. Inasmuch as one of us (E.L.Y.)

had been interested in the postoperative use of amniotic fluid and because both from reports and personal use felt convinced that a beneficial reaction took place it seemed reasonable to believe that the pre-operative use might give the same degree of protective reaction.

In 1927 and 1929 Johnson and Warren published their papers on the use of amniotic fluid in the peritoneal cavity after operation. Since that time other reports have been forth coming from Lacey Trussler and others (3, 4, 11). It seems clear that there is a certain beneficial reaction in the peritoneum tending to stimulate the normal healing process and as a purely secondary fact because of this minimizing postoperative adhesions and lessening the tendency toward the development of peritonitis. Experimental attempts to produce peritonitis in control animals have met with considerable difficulty as the animals tend to die promptly from toxic absorption or else to recover without going through the clinical picture of peritonitis as we see it in the human being. Various agents have been used to irritate the peritoneum and in his studies on peritonitis, David found that a well formed exudate coming as the result of peritoneal injection of 5 per cent turpentine emulsion completely prevented the absorption of *Bacillus coli* injected into the peritoneal cavity. It seemed to us then that it was reasonable to try the pre-operative injection of amniotic fluid and see if we could demonstrate any beneficial effect from it. The harmlessness of the substance had been already demonstrated beyond question and therefore it seemed fair to start at once with clinical cases as well as to attempt to see what actually took place in animals. Accordingly with the co-operation of the pathological department of the Harvard Medical School and the East Surgical Service at the Massachusetts General Hospital studies were started. There were several problems involved, the first of which was the question whether any peritoneal reaction took place without a constitutional reaction too severe to justify further use. Another was whether one injection or more than one injection was best, and at what time before operation it should be given.

CLINICAL WORK

It is obvious to any surgeon that a great deal of clinical evidence must be available before deductions of value can be made. In this study we have used pre-operative injections of amniotic concentrate in 49 cases involving for the most part operation on the large intestine. The technique has been as follows. In the first 10 or 12 cases, we used amounts of the fluid varying from 50 to 200 cubic centimeters. We tried using it 1 day, 2 days, and 3 days before operation. Inasmuch as the result seemed to be the same we began to use the time interval suggested by the curve of aseptic peritonitis found in experimental animals. Thus, for the last 35 cases at least, the injection has been of 50 or 100 cubic centimeters only given from 5 to 8 hours before operation. It is given through a small blunt lumbar puncture needle paying due attention to any question of previous adhesions. In one case where there had been multiple abdominal operations we did not use it at all although we should like to have done so for fear of injuring bowel as this procedure carries with it the same risk as any abdominal puncture that of injuring bowels. In fact that question came up in the only death where postoperative peritonitis was the possible cause. As a rule there is very little reaction. Several times when the house officer has awakened the patient at three in the morning to give the injection the patient has gone right to sleep again without discomfort. Nevertheless in some cases there will be abdominal cramps, nausea, or a little of both but as a rule there is not enough disturbance to make the reaction of serious moment to the patient. At the time of operation, if it is done at the height of the reaction there will be present a cloudy fluid of some 6 or 12 ounces in amount which coagulates very quickly which is sterile on culture and has a polynuclear cellular content on smear. The intestines are injected throughout. Even up to 15 hours, the intestines will still be injected and there will be a thin coating of exudate containing mostly polynuclear leucocytes. The patient's leucocyte count taken before the injection and at the height of reaction will increase from normal or slightly above up to 25,000 or even

30 000 The leucocyte count in the peritoneal fluid will be from 50 000 to 100,000. The culture is sterile. Though impressions are deceptive there is a very strong impression in our minds that the postoperative course in these cases is much smoother than in those cases in which no amniotic fluid was used.

In these 49 cases there have been 3 deaths. All 3 of these have been studied at post mortem and the details are as follows:

One death was shown to be due to postoperative pneumonia and no peritonitis was present.

The second death occurred in a woman of 53 years with an early carcinoma of the sigmoid. A resection and end-to-end anastomosis was done over the Young clamp without difficulty and a caecostomy was done at the same time. The patient did very well following operation. Her bowels moved on the fifth day by rectum. On the afternoon of the seventh day there suddenly occurred a severe abdominal pain with collapse and evidence of some serious intra abdominal accident. Patient's condition became very rapidly worse and she died in 24 hours. Autopsy showed a perforation about half an inch from the suture line which was undoubtedly due to the cutting of one of the fat tabs with interruption of a terminal artery as described by Rankin. The clinical course up to the time of death and the appearance of the peritoneum at autopsy strongly suggested that there had been no peritonitis up to the time of this perforation.

The third death occurred following a combined abdominoperineal resection for cancer of the rectum. This patient had postoperative intestinal obstruction which required a secondary operation. At the original operation there was localized reddening at one spot on the bowel which the operator thought might have been due to the needle. At the second operation a very slight amount of peritonitis was present and it was impossible to say whether this was merely a congestive change due to the obstruction. However the patient did have at autopsy a moderate amount of peritonitis. This is the only case in which postoperative peritonitis as such was the cause of death.

If we compare these figures with those for patients who were operated upon at the Massachusetts General Hospital during the same period of time and in whom no preoperative intraperitoneal injection was used the figures are as follows: 46 cases of large intestinal surgery with 8 deaths from peritonitis, which gives us a mortality of 17.3 per cent. These include many cases in which nothing but a colostomy was done. If we take only those cases in which the bowel was resected, there was a mortality of 38 per cent. Inasmuch as the 49 cases in our series with the injection all include resection it is fair to use the latter figure of 38 per cent with which our mortality of 2 per cent should be compared. Inasmuch as the type of case is the same and the technique was the same in other respects it seems that this difference in mortality was not purely accidental.

In one case we used this fluid with the addition of gum tragacanth as has been recently done in connection with the intraperitoneal use of colon vaccine. Since in this case there was no change in the appearance of the peritoneum, the smear taken did not show any difference in the type of cells and since the technique is somewhat more complicated we have not repeated the use of this combination.

The results from the cases available up to the present are sufficiently striking to point toward certain conclusions which seem to us to warrant further study along this line. As a matter of fact, they have seemed so suggestive to us that we are using the injection in all such cases as a routine because we believe that the aseptic peritonitis caused by the amniotic fluid lessens the risk of postoperative peritonitis.

EXPERIMENTAL WORK

Investigation of the reaction of the peritoneum to mild irritants both chemical and bacterial have shown the occurrence of a cycle of cellular response. Cappell in 1930 demonstrated this by the use of supravalid stains following intraperitoneal injection of guinea pigs with a concentrated infusion broth. He found the first cells to respond were the small mononuclears followed during

TABLE I.

Time	Poly-morphonuclears per mm
10 00	injection
11 00	occasional
12 00	800-900
1 00	900-1000
2 00	1800
3 00	3000
4 00	3500
5 00	4200

the initial 18 hours by an increase of polymorphonuclears up to 50 per cent. The maximum reaction occurred between 18 and 24 hours after injection. Repeated injections intensified the reaction stimulating mononuclear more than the polymorphonuclear cells.

Amniotic fluid concentrate is a very mild peritoneal irritant and the reaction of the peritoneum to its presence was investigated as well as compared to hormone broth and hypertonic glucose solutions.

Guinea pigs weighing about 250 grams were used. The animals received an intraperitoneal injection of 10 cubic centimeters of amniotic fluid through a blunt hypodermic needle introduced slowly through the parietes. Hourly cell counts were then done on the fluid aspirated from the peritoneal cavity through a similar needle. It was necessary to dilute the fluid immediately since the fibrin present coagulated rapidly. Counts were done hourly during the first 6 hours after injection. A typical chart is shown in Table I.

If a second injection of amniotic fluid were given 24 hours after the first a more pronounced exudation of cells occurred. It was hard to count the cells accurately because the coagulum formed rapidly. This consisted of fibrin loaded with polymorphonuclears in its meshes. Whereas during the first 6 hours after the first injection the fluid aspirated was clear or only faintly cloudy that after the second was viscid yellow and coagulated rapidly on addition of acid and showed cell counts varying from 32,000 to 55,000 polymorphonuclears. During this period the mononuclear cells increased to 30 per cent or more.

Series of counts were done on the fluid after injections of hormone broth and 10 per cent glucose in saline. Cell and fibrin response

after the broth was similar to that after amniotic fluid, but was very slight after glucose usually amounting to a few hundred cells per cubic millimeter with a faint trace of fibrin after treatment with acetic acid.

Guinea pigs receiving 0.5 to 1.0 cubic centimeter intraperitoneally of a saline emulsion of cultures of *Bacillus coli* from agar slants died very rapidly usually within 18 hours with little or no peritoneal reaction in the form of vascular infection, cellular exudate or fibrin deposit. Those animals which received first an intraperitoneal injection of amniotic fluid followed in 24 hours by equal doses of the saline emulsions of *Bacillus coli* survived from 36 to 72 hours, and showed a well marked peritonitis with fibrin and exudate. Smears from the peritoneal cavities of the animals without amniotic fluid were found to be loaded with organisms while the exudate in the injected animals contained many less.

This experimental work is of necessity incomplete. We both came to feel early in the work that the most important thing we could do was to attempt to establish the curve of reaction. This seemed to reach its peak approximately 6 hours after the injection. We depended on the clinical study to give an answer as to the clinical value of this procedure. Further experimental work is being done by others which will tend to help establish the validity of this procedure from the experimental point of view.

SUMMARY

1. A series of cases is here presented in which an attempt has been made to produce a protective reaction in the peritoneum by the use of amniotic fluid concentrate injected before operation. In the series of cases here reported the mortality was reduced to 2 per cent.

2. A very brief résumé of the experimental work attempting to establish the maximum effect of this injection is given.

3. We believe that the use of this non-specific peritoneal stimulant contributes materially to the safety of operations in the peritoneal cavity involving resection of the large bowel.

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MALIGNANT DISEASE OF THE FEMALE GENERATIVE ORGANS IN THE FIRST THREE DECADES OF LIFE

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ORDINARILY malignant disease is looked upon as a malady occurring in middle life but it is a known fact to pathologists and gynecologists of large experience that malignancies of the generative organs in childhood and young adult life are relatively speaking not uncommon. It is true that with each decade the incidence of cancer increases and that certain types, such as uterine and breast malignancies, occur chiefly in the fourth and fifth decades.

Williams states that the incidence of cancer increases with each decade after 25, rising until the seventh decade and that females are more precocious from the start as is especially noticeable in the age period 45 to 55.

Observation of malignancy in young adults during the past few years prompted us to review our records and if possible to determine any facts of importance in relation to symptoms, the stage of the disease at the time of admission, treatment and the results of treatment given.

The experience of all who treat malignancy has been that the disease is virulent in young adults, running a much more rapid course than in patients of middle or old age.

The campaign by various societies for the control of cancer is being carried on more vigorously of late than ever before. This education of the lay people presents the family physician and surgeon with a greater responsibility than ever before in detecting these lesions at the earliest possible moment so that proper and energetic treatment can be instituted.

The yearly or birthday examination will be of benefit in detecting more early cases but much greater stress must be laid upon the significance of the presence of sores, abnormal discharges, tumor formation, and other symptoms such as pain and pressure and the fact that cancer is a possibility in childhood and young adult life.

There were 2,405 patients suffering from malignant disease of the female generative organs admitted to the State Institute for the Study of Malignant Disease up to October 1, 1933. We were somewhat astonished to find 114 of these patients were 30 years of age or younger. 4.6 per cent of the total gynecological malignancies admitted. Table I shows the incidence in each group.

TABLE I—INCIDENCE

Pathology and location of lesion	Total admissions	No. patients age 30 or younger	Per cent of total
Cervix			
Epithelioma	58	24	4.9
Sarcoma			
Malignant polyp	1		
Adenocarcinoma	40		6
Embryonal carcinoma and epithelioma			4.7
Ovary			
Epithelial cystadenocarcinoma			
Adenocarcinoma	11	6	8
Carcinoma	23	6	12.2
Cystadenoma	124	9	5.6
Sarcoma	3		2.3
Malignant teratoma	3		2.3
Uterus			
Adenocarcinoma and carcinoma			
Malignant leiomyoma	291		12
Sarcoma	10		
Carcinoma epithelioma			
Vagina			
Adenocarcinoma	6		
Epithelioma	80	5	1.7
Sarcoma (Gartner's duct)			
Vulva			
Adenocarcinoma			
Epithelioma	17	3	5
	2,405	114	

CERVIX

Cancer of the cervix uteri in young women constitutes 68 per cent of the 114 cases presented here or 4.9 per cent of the total number of cervix epitheliomata admitted.

Careful inquiry into the histories of these cases revealed (1) that only one of the 78 patients was unmarried (2) the 7, other patients had from one to eight pregnancies, bearing out the theory that trauma and inflammatory lesions have a large influence in the production of malignancy of the cervix.

TABLE II.—DURATION OF SYMPTOMS

Group	Shortest duration	Longest duration	Average duration
I	1 month	3 years 8 months	9 months
II	3 months	1 year	6 3 months
III	weeks	3 years	7 8 months
IV	4 days	4 years	8 5 months
V	3 weeks	1 year	8 4 months

(3) that all gave a history of discharge so called leucorrhœa, for varying periods of time up to 7 years (4) that the important symptoms referable to menstrual periods consisted of bloody, watery or foul discharge between the regular periods (see Table IV for age incidence)

In comparing the symptom of discharge in the various stages of advancement little could be learned. In recording the 78 cases of epithelioma of the cervix the Schmutz grouping was used. Ten cases fell into group I, 4 into group II, 29 into group III, 27 into group IV and 8 into group V.

Table II shows a comparison of the duration of the symptoms, bloody or watery discharge (leucorrhœa not included) in the different groups. It will be seen that there is little difference of duration in the early and far advanced cases so not much knowledge is gained to guide us in the early symptomatology.

Blood as a symptom must be looked upon as accidental—yellowish, watery or foul smelling discharge usually precedes the showing of blood which does not occur until the tumor begins to ulcerate and break down. Abnormal discharges in young women are indications of pathology which usually is found to be endocervicitis with so called erosion. This condition may be considered a precursor to malignancy according to Ewing who says 'A chronic endocervicitis precedes cancer in the great majority of cases and the routine examination of this tissue reveals abnormalities in the morphology and position of the epithelium which constitutes precancerous conditions.'

Bailey in a monumental piece of research 'An Inquiry into the Basic Cause and Nature of Cervical Cancer' which is exceedingly illuminating and worthy of careful consideration by all who are endeavoring to prevent

malignancy of the cervix also states that the ultimate sequel to erosion is malignancy.

It will be found that cancer prevention in this particular group of malignancy lies within the grasp of the family physician who should acquaint himself with the evidences of cervicitis ulcerations erosions and leucoplacæ areas on the cervix so that he may advise proper treatment for these precursors of malignancy.

If seen early there is a good possibility of eradicating cervical cancer. The recognition of the disease in its early stage especially in young women is important as it may be the means of saving the life of a young mother so needed for her children's sake.

Attention is frequently called to the fact that the incidence of cervical cancer is lower in Jewesses. Sorshy says 'The observance of the Mosaic code undoubtedly produces a high degree of sexual cleanliness and it is suggested that this cleanliness with its concomitant restrictions on cohabitation at times when rest is probably beneficial as after parturition and menstruation is a factor in the lower incidence of uterine cancer among Jewish women—the regulations of the Mosaic code make the appearance of discharges a cause for inquiry as to its nature and a woman with a blood stained discharge is theologically 'unclean'.' None of the patients in our group was Jewish.

Parabuceu quoted by Stout collected data from several Russian gynecological clinics which show that cancer of the uterus in women from 24 to 30 represents no less than 24 per cent of all cases of uterine cancer. He attributes this to the increasing use of artificial abortion and anticonceptual methods in Russia.

The results of treatment given in this group of patients have been as good as the general average in cancer of the cervix in groups I and II. Group I yielded a 50 per cent 5 year cure in the 6 cases in which the patients were admitted and treated 5 or more years ago. Only one patient in this group died from the disease, the 2 others were lost trace of a few months after treatment and we have been unable to ascertain the end result so that this 50 per cent is the absolute 5 year cure. Of the

TABLE III.—AGE INCIDENCE—OVARY

Pathological group	10-15 years	16-20 years	21-25 years	26-30 years
Papillary cystadenocarcinoma				4
Adenocarcinoma				
Carcinoma			1	
Sarcoma				
Malignant teratoma			1	

The youngest patient was 11 years of age (carcinoma).

4 patients admitted and treated less than 5 years ago 2 are clinically well for 11 months each, or since the time of their original treatment 1 has not returned since treatment and we have been unable to ascertain the result of treatment, and 1 died 4 years after admission from recurrence and extension of the disease.

The group II cases yielded a 33 per cent 5 year cure in the 3 cases with admission and treatment 5 or more years ago. One other patient in this group admitted 10 months ago is alive and free from the disease since the time of original treatment.

In the groups III, IV, and V cases palliations only were rendered none survived the 5 year period. This is very discouraging in comparison with the general statistics.

Thirteen of the group III cases were admitted 5 or more years ago all died—8 in less than a year 2 between 1 and 2 years 2 between 2 and 3 years, and 1 in 4 years and 8 months. This last patient was clinically well for almost 2 years following her original treatment but had a recurrence which progressed and caused death. Of the 16 other patients admitted less than 5 years ago—5 are clinically well from 4 months to 13 months 2 are having palliation for 5 months each 1 is progressively worse after 6 months in 1 living 1 year 5 months after admission the local lesion is clinically well but there are metastases in the abdominal lymph nodes 1 living 2 years 9 months, was clinically well for 2 years when there was a recurrence which was retreated and she is again well for 8 months 1 was lost trace of after being clinically well for 4 months 5 died—4 in less than a year and 1 in 1 year 2 months.

Sixteen of the group IV cases were admitted 5 or more years ago 10 died in less than a year

TABLE IV.—AGE INCIDENCE—EPITHELIOMA CERVIX

Age	18	20	22	24	26	28	30	32	34	36	38	40	Total
Group I					1		2						3
Group II													4
Group III				2		2	5	4	10	10			23
Group IV				1	2	2	5	2	6	17			27
Group V				1	1		1	1	1	1			6
Total				4	7	4	9	12	16	27			79

2 in 1 to 2 years, and 4 were lost trace of unimproved in from 4 months to 1 year 8 months. The 11 others admitted less than 5 years ago also died—8 in less than a year and 3 in 1 to 2 years.

Of the 8 cases in group V 1 was not treated 1 was lost trace of in 7 months, 4 died in less than a year and 2 in 1 to 2 years.

One case of adenocarcinoma of the cervical canal aged 27 years, and 1 case of adenocarcinoma and epithelioma of the cervical canal aged 29 years, were treated. This latter case had recurred after operation, and at the time of admission both were far advanced. Following irradiation 1 was lost in 2 months and the other succumbed to the disease in 6 months.

OVARY

Frings in speaking of malignant disease of the ovary says: All ages are susceptible from birth to senility and that all lesions with few exceptions, are very malignant.

We have 23 cases of malignancy of the ovary occurring in patients 30 years of age or younger to report, 6 papillary cystadenocarcinoma, 6 adenocarcinoma, 9 carcinomata, 1 sarcoma and 1 malignant teratoma.

Thirteen of the 23 patients were unmarried 2 of the married patients had no pregnancies 4 one pregnancy 2 two pregnancies 1 three pregnancies and 1 four pregnancies.

The age incidence in each pathological group is shown in Table III.

Of the 23 cases, only 2 were not proved pathologically 1 had no operation and the other had had a laparotomy but no section taken. The majority of these patients had been operated upon before admission. One patient was not treated the others received

either high voltage X ray or 4 gram radium pack treatment. Six of the patients have lived from 5 months to 8 years after treatment and have been free from the disease for 5 months, 6 months, 2 years 2 months, 2 years 8 months, 2 years 10 months, and 4 years, respectively. This latter patient is alive 8 years since the time of admission but suffered a recurrence 4 years 4 months after original treatment and then was operated upon and treated again. Three others are living but are not free from the disease, 2 for over a year with some palliation, and 1 for 2 months unimproved. Three were lost trace of and the other 10 died—7 in less than a year, 2 in 1 to 2 years and 1 in 5 years 11 months.

UTERUS

One case of adenocarcinoma of the uterus, patient aged 30 years, was admitted in September 1930 following curettage. Upon admission she was treated with radium and high voltage X ray. This patient reported only once following treatment and then was lost so that the result of treatment was undetermined.

Two cases of malignant leiomyoma were recorded. 1 occurred in a patient aged 24 years married, menstrual periods from the age of 14 were regular but rather profuse lasting from 7 to 8 days. She had had one miscarriage but no other pregnancies. Seven weeks before admission menstrual periods became longer and harder. Hysterectomy was performed for a supposed fibroid uterus. Pathological examination showed this tumor to be a malignant leiomyoma. She received high voltage X ray treatments 1 month following operation and was alive without recurrence 5 years and 7 months after treatment when last examined.

The other case occurred in a patient aged 24 years married, 6 children. This woman had given birth to a child 6 months previous to admission following which she had a 9 day hemorrhage. Four months after the birth of the child a hysterectomy was performed for a malignant leiomyoma. At the time of admission there was a recurrence in the vault of the vagina extending into the broad ligament areas. She was treated by radium applications

but the lesions progressed out any palliation. She showed recurrence of metastases.

One case of malignant leiomyoma was observed in a patient aged 24 years, mother of 2 children. Menstrual periods were irregular and she had a yellowish discharge previous to admission. She was operated upon following a hysterectomy. The body of the uterus was removed. Choriocarcinoma was diagnosed. She died 11 months after admission.

Three cases of malignant leiomyoma were observed. 2 in 1929 and 1 in a patient aged 24 years.

One patient aged 24 years in 1932 gave a history of 7 months, last 10 months. She was 3 months pregnant. Her family doctor advised her to abort which she refused. She showed a recurrence of the tumor. Upon admission she was operated upon and implanted with 20 mg. of radium for a total dose of 100 mg. following which the tumor was interrupted to 5 cm. She was born April 1, 1908. December, 1929, she had a recurrence, 14 months after the necessity of the operation which in this case was not of a mother up to the life of 2 children. treatment.

One was in 1931. She gave a history of only, over 2 years, was far advanced and lateral, treated by radium benefit, and 11 months after

complete relaxation and apparent comfort. Uterine contractions occurred strongly and at frequent intervals. The second stage was completed without laceration and any additional anesthesia. I believe that epidiotomy could have been done on this patient without inhalation anesthesia.

Satisfactory as was the course of labor in cases such as these instances were encountered in which there seemed to exist a refractoriness to the dial urethane. This is shown in the following

CASE 3. Primipara, aged 25 years. Labor was quite well advanced when she was admitted to the hospital. First stage was almost completed. An injection, 2 cubic centimeters of the dial-urethane solution was given intravenously practically without effect. In 30 minutes a second injection of 2 cubic centimeters was given, with no definite effect. Recourse to inhalation anesthesia was necessary. A second degree perineal laceration was sustained.

Although unfamiliar with the work of Garcia or Holtermann at the time, it was obvious to me that more elasticity in dosage should be employed in order to secure satisfactory results in these resistant cases. Dial urethane in contrast to barbitol produces its effects very soon almost immediately after entrance into the blood stream. By making the injections very slowly (about 1 cubic centimeter per minute never more rapidly) it is possible to adjust the dosage to the individual patient much more accurately than by a fixed volume-dose as used by Nelson.

TECHNIQUE

The procedure which I now follow is as follows:

The patient is told that she will feel relaxed and sleepy from the injection, a matter of some importance because, otherwise, alarm may be experienced over the peculiar sensation. Four cubic centimeters of the solution are drawn up into a 5 cubic centimeter syringe and the needle thrust through the vein wall. Injection is made slowly the patient being constantly questioned and the injection discontinued when she no longer responds. In some cases, 2 cubic centimeters of the solution will suffice; in others, it may be necessary to inject the full 4 cubic centimeters. I have never given in excess of this latter amount in any single injection. If sound sleep does not

occur between pain a second injection of 2 cubic centimeters is given in 30 minutes. Further injections, each of 2 cubic centimeters may be given but I have not exceeded a total of 8 cubic centimeters in the course of any labor.

I have now used the dial urethane solution in 56 patients and am definitely convinced that, used according to the method just described it is the most satisfactory obstetrical analgesic I have ever employed.

As to the safety of dial urethane intravenously in the manner described far reaching conclusions can scarcely be drawn from the limited number of cases I have observed. It is worthy of note however that Nelson too in his series of 110 cases, records no undesirable side-actions, and that Marney in a series as large and with a dosage 50 per cent greater concludes that the preparation is perfectly safe.

The following two cases are especially interesting.

CASE 4. Multipara, aged 36 years in the ninth month of pregnancy. She was toxic: urine albumin, 4 plus; blood pressure, 110 over 110; pulse, 112; ordematous nitrogen retention; eye ground vessels tortuous and dilated. Dial-urethane 4 cubic centimeters was administered and a Vorhees bag inserted and inflated. Four hours later the bag was expelled and immediately after a live fetus was born. There was no bleeding and complete recovery followed.

CASE 5. Primipara, aged 28 years, 6 months pregnant. Patient was profoundly toxic, had a small vagina and long tight cervix. She was given dial-urethane 4 cubic centimeters, plus morphine $\frac{1}{16}$ grain. The cervix was dilated and a Vorhees bag was inserted and inflated. In toxic cases in which fetal life is not to be considered, great help can be had by adding morphine $\frac{1}{16}$ to $\frac{1}{8}$ grain. The uterus was left to empty itself which it did 24 hours later.

Interesting data as to the permissible dose of dial-urethane are contained in the papers of Muller and Hoven. These authors employed the preparation for narco-sustained therapy in patients with mental disturbances bringing about unconsciousness for prolonged periods during a period as long as 10 days. By either intravenous or intramuscular injection, they believe that the single dose should not exceed 4 cubic centimeters nor should the amount given in 24 hours be

greater than 8 cubic centimeters. One should recognize however, that scopolamine or opium preparations were administered simultaneously and that the treatment was carried out over a period of days. Muller is of the opinion that renal insufficiency and respiratory tract infection are contra indications to the use of dial urethane solution in the massive dosage necessary. Irving and his associates likewise hold the belief that barbiturates should not be used in obstetrics 'when the patient has any infection of the upper or lower respiratory tract. To this I cannot subscribe, dial urethane in the dosage employed by me has seemed especially serviceable during a recent epidemic of influenza where I resorted unhesitatingly to its injection in 6 patients with more or less severe infection, and encountered no evidence of untoward results. In these patients I am convinced that ether, certainly would have been most dangerous, and I am by no means sure that even nitrous oxide-oxygen could have been given with impunity. It is worthy of note that Muller finds the dangerous period under dial urethane from the third to the fifth day of administration, much later than the effect would persist in any parturient patient. With dial urethane analgesia carried out as described it is possible to rouse the patients at any time sufficiently to have them take liquids and this is always done in cases of prolonged labor.

Hussy felt that dial stimulated uterine contractions. McNeile and Vruwink state that the dial urethane solution hastens cervical relaxation. Nelson is of the opinion that labor is materially shortened by the preparation. My experience also leads me to conclude that dial urethane in most cases is responsible for more prompt delivery although in rare instances it may cause some delay. It is not clear how this result is accomplished. Certainly cervical relaxation seems favored furthermore. I have the impression that uterine contractions are increased in force and frequency but definite proof of this is lacking. In no instance have I observed undue tendency to postpartum bleeding but it should be mentioned that my routine practice is to inject 1 cubic centimeter of pituitary solution at the conclusion of the third stage.

As to the possibility of carrying out operative procedures under dial urethane analgesia my experience does not coincide fully with that of Nelson who apparently never found recourse to supplementary anesthesia necessary for "forceps, versions and extractions, episiotomies and necessary repair." In all our cases requiring episiotomy or perineal repair provision is made for administering ether by inhalation. A few cases require a small amount of ether others do not.

Restlessness, so frequently a troublesome feature after amytal and apparently after pernocton and pentobarbital (6), has been practically absent in my series under dial urethane. We have had one patient who had to be restrained. A few others were slightly restless but not sufficiently so as to be particularly annoying. However the importance of having the patient constantly under the observation of a responsible attendant until consciousness is fully recovered cannot be too strongly stressed.

There is usually a slight fall in blood pressure immediately after the injection but this has never been alarming and the pressure soon returns to normal. Marney warns against too rapid injection stating that respiratory depression may result unless this precaution is observed. With the rate I have recommended (not over 1 cubic centimeter per minute) no disturbances of this nature have been noted. Double vision as reported by Nelson is not infrequent but soon passes off. Cutaneous rashes have not occurred in any of my patients but may result from administration of dial.

It is gratifying to state that in my cases there have been no stillbirths, nor have I encountered any instances of serious respiratory depression in the child. This is a pleasing contrast to what is seen after administration of adequate doses of morphine or other opium derivatives and differs also from the experience of Irving and his associates after employment of amytal, pernocton, or pentobarbital.

At any time if the patient is slow to recover or seems depressed the condition may be corrected by intravenous injection of coramine marketed in ampuls and stated to be a specific

In all cases of barbiturate depression The dose varies but as much as 10 cubic centimeters can be used at a single injection as pointed out by Hoven We have not found it necessary for a mother but we always have the ampuls on the table for injection into the umbilical vein in case the infant manifests respiratory depression

SUMMARY

The dial urethane solution in ampuls seems to be a safe and effective obstetrical analgesic

Biological dosage is recommended that is, the slow intravenous injection of the solution (not over 1 cubic centimeter per minute) until the patient no longer responds to questions. Subsequent injections of 2 cubic centimeters may be employed as necessary but the initial dose should not exceed 4 cubic

centimeters nor should the total during 24 hours be in excess of 8 cubic centimeters except in unusually large patients.

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CLINICAL SURGERY

FROM THE LAHEY CLINIC

INTRATHORACIC GOITER

FRANK H LAHEY M D F A C S AND N W SWINTON M D BOSTON

ANATOMICAL CONSIDERATIONS

IN order to understand the mechanism whereby a tumor arising in the thyroid gland, which is entirely extrathoracic, may eventually become entirely intrathoracic, it is essential that the anatomy of the thyroid gland be visualized. Because of the location of the gland, it is involved in the motion of swallowing, it bears relation to the pretracheal and prevertebral fascia, and it is placed in a plane which leads into the superior mediastinum. The covering of the gland with prethyroid muscle has a tendency to guide tumors of the thyroid gland into the superior mediastinum. We know in addition, that in its development the thyroid descends from its origin in the fetus at the base of the tongue, occasionally progressing even beyond the normal into the mediastinum. This last factor we have found to have little to do with intrathoracic goiters in an experience now amounting to over twelve thousand operations, we have never seen an intrathoracic goiter which we felt was the result of an excessive developmental descent of the thyroid gland.

The thyroid gland is located on the upper tracheal rings. In front of it are the prethyroid muscles attached to the sternum and the sternoclavicular junction and behind it is the prevertebral fascia. The glands ascend and descend with each act of swallowing in this muscular and fascial plane which leads, as stated directly into the mediastinum.

Therefore when an adenoma of either lobe or the isthmus of the thyroid enlarges it must make room for itself in one of two directions. It either causes the prethyroid muscles to bulge forward thus producing a projection of the neck, in which case it is obviously an extrathoracic goiter or it projects downward into the mediastinum, in which case it is an intrathoracic goiter.

A lateral silhouette of the upper part of the thorax shows that the thorax tends to taper toward

the neck, spreading out as the chest widens downward toward the diaphragm (Fig 1).

When an adenoma has passed the upper thoracic aperture, as indicated by the arrow in Figure 1 and has become intrathoracic, as we have repeatedly stated in discussing this subject it can increase its diameter only by descending and it is this widening of the more or less spherical adenoma or cyst which, due to the tapering of the chest, pushes it lower and lower into the mediastinum.

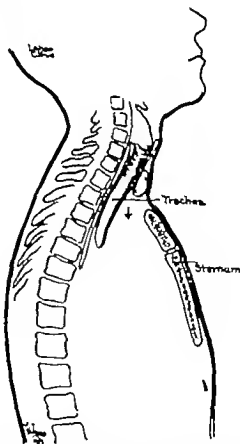


Fig 1. Note the taper of the chest as seen in lateral silhouette, showing how increase in diameter of a spherical adenoma as shown in Figure 6 causes it to descend further into the mediastinum.

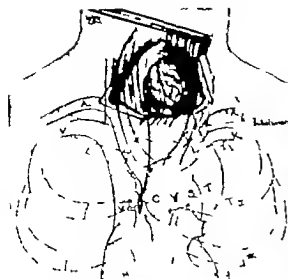


Fig. 2. A diagrammatic illustration of an intrathoracic cyst (degenerated adenoma) which produced the nearest escape from a fatality on the operating table from choking seen in our experience—cyanosis, unconsciousness, and complete absence of air entering lungs. Emergency puncture of the cyst resulted in immediate and complete relief of obstruction permitting deliberate removal of the sac.

Occasionally the statement is made that patients with exophthalmic goiter (primary hyperthyroidism) have intrathoracic goiters. Never in our experience have we seen exophthalmic goiter or primary hyperthyroidism—hyperthyroidism with true hyperplasia—become truly intrathoracic. In men, the lateral lobes are lower than in women but never truly intrathoracic in our experience.

The most common type of intrathoracic goiter is the discrete adenoma in the region where goiter is endemic, the nodular multiple adenomatous goiter of the endemic type is, of course, the most common. Occasionally cysts which are entirely intrathoracic are seen; in fact, the nearest escape from a fatality by immediate choking which I have ever seen was in a patient with intrathoracic goiter who had a large intrathoracic thyroid cyst (see Fig. 2). These cysts, however originally were thyroid adenomata but the adenomatous element within the capsule became necrotic, was absorbed, and replaced by fluid. Therefore, the fact that intrathoracic thyroid cysts do occur is further evidence that in practically all of the cases the cysts are adenomatous in origin.

Occasionally a diffuse colloid goiter is partly intrathoracic, but almost never does such a goiter become frankly intrathoracic. The explanation



Fig. 3a. Note the anteroposterior pressure on the trachea by an intrathoracic adenoma most marked at the point indicated by the arrow. The anterior line of the trachea displaced backward has been made more definite by small ink dots.

for this is that the diffuse colloid goiter is usually the result of an early degenerative change in the gland preceding the appearance of the multiple nodules which are scattered throughout the gland and which are so characteristic of endemic goiter. The diffuse colloid condition as a rule indicates a progressive state. The degenerative process rarely remains stationary. If the goiter has existed long enough to become intrathoracic, and descent into the thorax takes time, the transition has usually taken place from a diffuse colloid goiter into a goiter of the multiple nodular endemic adenomatous type. Therefore, for practical purposes, all intrathoracic goiters should be considered as adenomatous in type—the discrete adenomata, the multiple adenomata, or the thyroid cysts which were originally adenomatous.

CLINICAL SIGNS OF INTRATHORACIC GOITER

The clinical signs of intrathoracic goiter are produced almost entirely by pressure upon the trachea and the internal jugular veins. Rarely is there injury to the recurrent laryngeal nerve as a result of the intrathoracic extension of an adenomatous goiter (see statistical figures later in paper).

The reason that the recurrent laryngeal nerve does not become paralyzed even in the presence of an enormous intrathoracic goiter is un-



Fig 3b. Note the wide trachea in the same case made more clear by ink dots. The widening is the result of anteroposterior pressure.

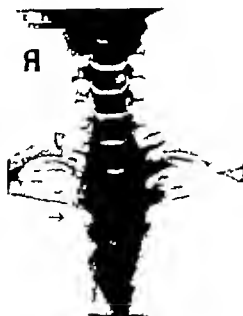


Fig 4. Lateral deviation and narrowing of the trachea at the point indicated by arrow due to an intrathoracic adenoma of the thyroid located lateral to the trachea. This is the most common type of intrathoracic goiter.

doubtedly the fact that the growth of the intrathoracic tumor is very gradual, thus causing slow stretching of the recurrent laryngeal nerve. As the stretching is so slow and so gradual the nerve is thus able to elongate its fibers and to adjust itself to its distorted position without interruption of its conductivity. In our experience recurrent laryngeal paralysis in intrathoracic goiter is so rare that when it does occur we are extremely suspicious that it is the result of malignant degeneration of the adenoma and furthermore we suspect that the recurrent nerve is involved in the malignancy.

In intrathoracic goiter three types of tracheal pressure effects are noted:

1. Anteroposterior pressure, when an adenoma arises in the isthmus of the thyroid descends behind the sternum in the middle line, and collapses the trachea from before backward as shown in Figure 3 a and b.

2. Lateral pressure is the most common and occurs as the result of lateral deviation of the trachea—as shown in Figures 4 5a b c, and d 6a and insert, b and c 7a and b 8 and 9. Adenoma of the thyroid usually arises in one of the lateral lobes of the gland and even though an adenoma does not arise entirely within a lateral lobe as it enlarges it tends to topple to one side or the other of the trachea which stands out as a semi-rigid tube.

3. Bilateral pressure. The next most common type of tracheal pressure is bilateral pressure, as

illustrated in Figures 10a and b and 11. Bilateral pressure is caused by a bilateral complete or incomplete intrathoracic goiter which collapses the trachea by pressure on either side. Sometimes the pressure is so great that the lumen of the trachea is merely a slit.

Clinically pressure on the trachea, as the result of complete or incomplete intrathoracic goiter, produces varying degrees of respiratory difficulty. It must be borne in mind that the narrowing of the trachea in these cases progresses so slowly and gradually that patients readily become adjusted to a diminished space for air intake and also to the associated stridor. These patients, as was true in the patient whose roentgenogram is shown in Figure 10a, become so used to bearing their own noisy breathing that they frequently fail to be impressed by it until attention is called to it by strangers.

When tracheal obstruction occurs within the thorax particularly as shown in Figure 6a, there will occasionally be peculiar attacks of suffocation at night when the patient is asleep. Patients with intrathoracic goiter and tracheal narrowing state that they are occasionally awakened in the night by choking that they struggle violently then regain their breath after a real ordeal, and go back to sleep. Witnesses to these attacks have stated that patients become extremely cyanotic and that the danger of sudden death from suffocation at times seems imminent in the struggle for breath.



Fig. 5a



Fig. 5b



Fig. 5d



Fig. 5c

Fig. 5a. A roentgenogram of a moderately large intrathoracic goiter showing moderate deviation of the trachea and descent to a little below the level of the arch of the aorta.

Fig. 5b. A photograph of the same patient showing absence of goiter on neck. One can also faintly see the dilated superficial thoracic veins near the sternal notch.

Fig. 5c. A photograph of a cross section of the intrathoracic adenomatous mass demonstrating its dimensions.

Fig. 5d. A roentgenogram of the mediastinum 5 weeks after removal of the intrathoracic mass showing the return of the trachea to the midline and the return of its caliber to normal.

The explanation of this phenomenon, we believe, is that a plug of tenacious mucus accumulates in the bronchus at night while the patient sleeps, lodges in the narrowed trachea, as seen at the intrathoracic level of the trachea indicated by the arrow in Figure 6a, produces obstruction, and becomes stuck there, finally to be dislodged by the violent efforts of the patient in his struggle to get air into his lungs. When such a history is presented by a patient, the presence of an intrathoracic goiter should be suspected and the patient subjected to an X-ray examination of the superior mediastinum to demonstrate the position and caliber of the trachea.

Another complaint associated with intrathoracic goiter particularly when the adenoma is located laterally in the chest, as shown in Figure 6a and insert is that the patient is able, for example, to sleep with the right side of his head on the pillow but cannot sleep with the left side of his head on the pillow or vice versa. This is due to

the fact that the trachea is collapsed laterally and when the head is angulated as shown in Figure 6a insert, the trachea closes even more closely and thus obstruction to respiration is produced, causing the patient to choke, wake up and change his position.

Complete or incomplete intrathoracic goiter of any extent is rarely seen without dilatation of the superficial thoracic veins. Figures 1a, b, c, and d. This dilatation varies with the amount of pressure exerted by the goiter on the internal jugular system and the amount of interference with the return blood supply from the head. Compensatory dilatation of the superficial thoracic venous system is established to take up the work of the obstructed internal jugulars. Therefore, the presence of a mediastinal lesion should always be suspected in the presence of dilated, superficial thoracic veins.

Another clinical feature occasionally seen should make one suspicious of intrathoracic



Fig. 6a

Fig. 6a. Showing the typical spherical intrathoracic adenoma of the thyroid with marked deviation of the trachea and narrowing from lateral intrathoracic pressure. Note the normal caliber of the trachea at the level of the upper arrow and the narrowing at the intrathoracic level of the arrow at which narrow point a plug of inspissated mucus may lodge at night and produce choking and the condition described in the text. The insert shows the type of discrete intrathoracic adenoma which also occasionally



Fig. 6b

makes it impossible for a patient to sleep with the head on one side as illustrated in diagrammatic illustration and described in the text.

Fig. 6b. A photograph of the patient, which demonstrates the complete absence of any visible goiter on the neck.

Fig. 6c. Compare with Figure 6a. This was taken 3 weeks after operation. Note the gradual return of the trachea toward the midline together with gradual increase in the caliber of the trachea following the removal of pressure from it.



Fig. 6c

goiter and that is the thickening of the skin over the face, due to edema resulting from interference with the return of venous supply from the head (Fig. 13). We have seen a few patients who have had a definite puffiness of the face which was immediately relieved on the removal of the intrathoracic masses.

When the intrathoracic goiter collapses the trachea from before backward as shown in Figure 3 the patient not infrequently complains of an inability to bend over. Bending over produces greater pressure upon the trachea, shuts it off and the patient chokes. He has learned, for example, that it is not possible for him to bend over and tie his shoes without choking. The finding of this symptom should make one suspicious of the presence of intrathoracic goiter.

Figure 14 illustrates the unusual combination of intrathoracic goiter and a pulsion oesophageal diverticulum in a patient who 15 years previously had had removed an intrathoracic goiter on the same side as the diverticulum. We first remove the diverticulum and will later remove the remaining partly intrathoracic goiter on the left. To remove the intrathoracic goiter on the left

first, might well complicate the removal of the diverticulum.

In Figures 14, 15, 16, 17, and 18 one may observe the depths well below the arch of the aorta to which the very deep intrathoracic goiters may descend.

We have been interested in reviewing our experiences with intrathoracic goiter for the purpose of confirming or dispelling certain impressions forced upon us by our somewhat large series of cases.

From the year 1915 to July 1, 1933, there were 4,363 cases of exophthalmic goiter or primary hyperthyroidism in which operation was carried out in the clinic. During this time there were 5,131 cases of adenomatous goiter in which operation was done in the clinic. This latter group includes adenoma as well as adenomatous goiter.

Of this group of 5,131 adenomatous goiters, 1,086, or 21 per cent, extended downward from the usual position of the thyroid gland into the superior mediastinum and thorax.

We have divided all goiters extending downward into two grades: the first, those in which the mediastinal extension is nearly to the arch of the



Fig. 7a. Marked pre-operative deviation of the trachea in case of partly intrathoracic goiter is indicated by dashes and arrows. Note that there is no marked narrowing of the trachea due to the fact that most of the goiter is extrathoracic.



Fig. 7b. An X-ray to show the return of the trachea to its normal position after removal of the adenoma, the lateral pressure of which caused its marked deviation.



Fig. 8. A typical very large and very deep unilateral intrathoracic goiter with tracheal deviation and extending well below the arch of the aorta. Note the marked deviation of the trachea outlined by dashes and indicated by arrow.

aorta, the second, those which extend to the arch of the aorta or beyond this level.

Of the 1,086, 745 or 68 per cent, were of the first variety, while 341 or 32 per cent, were of the second variety.



Fig. 9. A typical deep intrathoracic goiter extending to and beyond the level of the aortic arch. The characteristic lateral deviation of the trachea may be noticed in this instance also. The aortic arch is indicated by the arrow.



Fig. 10a. Bilateral pressure on the trachea by a bilateral intrathoracic adenomatous goiter. Note the normal width caliber of the trachea at level of the upper arrow and the bilateral collapse of the trachea to a narrow line at the level of the lower arrow where the bilateral adenomata are intrathoracic. In this picture one can visualize how intrathoracic goiters cause narrowing of the trachea. The adenomata in the mediastinum rest externally against the rigid chest wall and as they enlarge must collapse the compressible trachea which is interposed between the two enlarging adenomatous lobes.

As stated there was not a single instance in which the hyperplastic gland of an exophthalmic goiter became truly intrathoracic.

The upper pole of the thyroid gland occasionally extends behind the larynx or trachea at its normal level in such a manner as to produce obstructive symptoms by pressure on the back wall of the larynx which is unprotected by the thyroid cartilage. Such a condition occurred in 46 cases in our series. Also the gland of the patient with exophthalmic goiter may rarely extend behind the pharynx; we have 4 such cases in our series.

The age had little to do with the predominance of one of either group of intrathoracic goiters over the other.

Based upon 100 unselected cases, the average age in the first group was 52 years; in the second 48 years. The average age for the whole group was 50 years, indicating as already stated that it takes time for a goiter to progress downward from its normal position into the mediastinum and so the condition commonly occurs in middle and late life and rarely in young people.

The sex incidence corresponds quite consistently to the relation of goiter to sex and has as would be expected little or no relation to this condition.



Fig. 10b. Compare the pre-operative picture Figure 10a, with Figure 10b, the postoperative picture taken after removal of the intrathoracic adenomata. Note that with the removal of the pressure on the trachea it has almost entirely regained its normal caliber.

	Males	Per cent	Females	Per cent
Of Group I descent	68	9	677	91
Of Group II descent	64	18	277	82

The incidence of laryngeal paralysis due solely to the goiter and not to the operation as already stated was small in Grade I, 3 of 745 cases; in Grade II, 4 of 341 cases.



Fig. 11. The marked degree of narrowing at the level indicated by arrow which can occur with bilateral pressure from bilateral intrathoracic goiter.

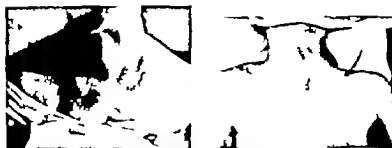


Fig. 1a and b. Dilatation of the superficial venous system in large intrathoracic and extrathoracic goiters.



Fig. 1c and d. Marked dilatation, particularly in the region of the sternal notch of the superficial veins in large completely intrathoracic goiters.

The effect on the trachea by pressure or deviation as shown by X ray was. In Grade I deviation in 93 per cent, no deviation in 7 per cent. In Grade II deviation in 98 per cent, no deviation in 2 per cent.

As one learns from dealing with these cases in numbers, and as may be seen in the X ray illustrations, intrathoracic goiter will rarely be present without some degree of tracheal pressure as evidenced by lateral deviation, anteroposterior narrowing or bilateral collapse.

The incidence of obstructive symptoms was more marked as would be expected, in the Grade II descents.

INCIDENCE OF OBSTRUCTIVE SYMPTOMS

	None Per cent	Mild Per cent	Severe Per cent	Unknown cases
Grade I	55	40	6.8	3
Grade II	15	4.5	23.5	9

To prove that the development of intrathoracic goiter could be avoided by frequent examinations and the removal of those goiters which tend to

descend into the thorax and to prove that it takes time for a goiter to become intrathoracic, the duration of the goiter was ascertained in 100 cases in each group. In Grade I the duration of the goiter was 13.04 years. In Grade II, 15.10 years.

The fact that obstructive symptoms late in the presence of the goiter brought many of these patients to the clinic for operation is verified in the histories of 100 unselected cases which show that although these patients had had goiters for an average of 14 years, they had had obstructive symptoms for an average of only 1 1/4 years before coming to us for operation.

Since most goiters which have become intrathoracic are adenomatous in character it is not surprising that in both Grade I and Grade II 70 per cent of the cases were non-toxic and 30 per cent showed thyroid toxicity.

As intrathoracic extension of thyroid tissue into the mediastinum theoretically brings about considerable anatomical distortion, one would suspect that there might be a high percentage of operative injury to the recurrent laryngeal nerve and to the parathyroid glands. Likewise, as the



Fig. 13



Fig. 14



Fig. 15



Fig. 16

Fig. 13. The thickening of the skin over the face due to edema, the result of an enormous intrathoracic goiter causing pressure at the superior thoracic strait on both internal jugular veins.

Fig. 14. An unusual combination of pulsion esophageal diverticulum on right and intrathoracic goiter on left. This patient had had an intrathoracic goiter removed from the right side 15 years previously. Note the deviation of the trachea, marked with dots, on the right and outline of the intrathoracic goiter on left, and the esophageal pulsion diverticulum on the right.

Fig. 15. A deep intrathoracic goiter well below the level of the arch of the aorta.

Fig. 16. The depth to which an intrathoracic goiter can descend. As may be seen from the clips on the goiter incision, this is an immediately postoperative X-ray of the mediastinum and the cavity remaining after removal of a deep intrathoracic goiter has been packed with gauze. Note on the left the level of the arch of the aorta and on the right, outlined by dots, the shadow of the gauze-filled pocket in the mediastinum. Note the lowest level, indicated by a second arrow well below the level of the aortic arch.

mediastinum is widely opened and drained in this operation and as it is at times a technically difficult procedure to remove deep intrathoracic goiters one might suspect that there would be a high mortality in this group of cases and in

addition a high incidence of tracheotomy. In order that we might visualize our statistics as relates to fatalities and the complications mentioned, we have tabulated our figures as shown in Table I.



Fig. 7. A postoperative X-ray picture after removal of a very deep intrathoracic goiter with roentgenographic ureteral catheters introduced into the resulting cavity to demonstrate its depth. Note at the level of the arrow the lowest roentgenographic catheter and its relation to the arch of the aorta.

It is of interest to note the definitely higher mortality rate in the deeply located Grade II intrathoracic goiters as compared with Grade I less deeply located goiters. This added mortality rate in these deep goiters is an additional argument in favor of the removal of goiters which are tending to become intrathoracic before they do become intrathoracic.

INDICATIONS FOR SURGERY

If we would establish the principle of examining all patients with goiters frequently, we will say perhaps once a year and removing the growth before it becomes intrathoracic, much of our difficulty in treating this condition could be prevented.

Once a goiter has become definitely intrathoracic, it should be removed, for if it is allowed to remain it will doubtless increase in size and, as this enlarges, it tends more and more to produce symptoms, it becomes more and more difficult to remove, the mediastinum must of necessity be more and more widely opened, the patients have become older and the risk of operation therefore



Fig. 18. An enormous intrathoracic multiple adenomatous goiter. Due to the calcification of the capsules of the adenomata, the extreme depth of this intrathoracic goiter can be ascertained.

greater. We therefore repeat that all goiters which are tending to become intrathoracic and all which have become intrathoracic should be removed.

Since we have published elsewhere our technique for the removal of intrathoracic goiters¹ we do not wish to repeat it in this discussion. Because of the importance, however, of the type of anesthesia employed in these cases and because the matter of anesthesia plays a considerable part in the mortality, particularly in the very deep intrathoracic goiters, we do want to discuss this part of the operative management of this condition.

ANESTHESIA

The best anesthesia for intrathoracic goiter in fact, the only anesthesia with which it is safe to remove any large intrathoracic goiter is intratracheal anesthesia. Whether one employs ether, nitrous oxide gas, ethylene or cyclopropane the most recent anesthetic which we are now employing experimentally, it then becomes purely a matter of the anesthetic a choice so long as an intratracheal catheter has been introduced.

In all intrathoracic goiters in which there is any considerable narrowing of the trachea and in which the intrathoracic tumor is of any considerable size, there will always be the danger of difficulty in making the tumor pass through the

¹The surgical management of intrathoracic goiter. Surg. Gynec. & Obst., 91, Jan., 1921, 214.

TABLE I.—IMMEDIATE POSTOPERATIVE COMPLICATIONS

IN GRADE I INTRATHORACIC GOITER

Year	Tetany	Postoperative laryngeal paralysis unilateral	Tracheotomy	Death	Mortality per cent
1908-1910 65 cases			1	4	8.4
1911-1912 33 cases	0	1	1		3
1913-1915		5	0	1	4/10

IN GRADE II GOITER

1908-1910 64 cases		4		6	9.3
1911-1912 6 cases	0	4	3	5	4.3
1913-1915 61 cases	0	5		4	3.5

The causes of death in the 21 fatalities were as follows

	Cases
Pneumonia	5
Cerebral hemorrhage	1
Thyroid crisis	5
Diabetes	1
Embolism	1
Postoperative hemorrhage and shock	1
Cerebral infarct	1
Mediastinitis	
Bilateral laryngeal paralysis	
Early cases with severe edema	

Dissection of both recurrent laryngeal nerves at autopsy in this case showed them to be intact and sound. The patient had incisions of thyroid tissue completely encircling her trachea, and her bilateral paralysis was doubtless due to stretching of the recurrent nerves in the removal of these tongues of thyroid tissue.

upper thoracic strait, thus producing pressure upon the trachea and without an intratracheal catheter causing the danger of suffocation.

It should be borne in mind in dealing with tracheal obstruction in intrathoracic goiter that the performance of tracheotomy is extremely undesirable (1) because the obstruction to the trachea in intrathoracic goiter being within the thorax is usually too low to be dealt with satisfactorily by means of the ordinary short tracheotomy tube, and (2) because the mediastinum has been widely opened and a tracheotomy in the

presence of an open mediastinum seriously presents the possibility of infection in this region and mediastinitis.

We therefore, feel that except in those goiters which are only partly intrathoracic and which obviously can be readily delivered, whatever type of anesthetic is employed it should be administered through a previously introduced intratracheal catheter. With the tube in place any amount of manipulation and pulling hauling and prying of the mass out of the mediastinum can be undertaken without danger of interfering with the respiration.

CONCLUSIONS

Any patient with mechanical interference to breathing should be suspected of having an intrathoracic goiter and should be subjected to an x-ray examination of the mediastinum.

In the presence of an intrathoracic goiter deviation or flattening of the trachea either laterally or anteroposteriorly together with the mediastinal shadow can be demonstrated in practically all cases.

Dilatation of the superficial thoracic veins should always make one suspicious of the presence of an intrathoracic goiter.

Any goiter which is low lying and tends to become intrathoracic should be removed before it becomes intrathoracic.

The introduction of a catheter between the vocal cords into the trachea makes the removal of large and difficult intrathoracic goiters infinitely more safe.

Statistics are given showing the incidence of Grade I and Grade II intrathoracic goiters. Figures are also submitted showing the age incidence sex incidence the incidence of preoperative and postoperative laryngeal paralysis, the incidence of tracheal deviation or pressure the incidence of obstructive symptoms, the duration of the goiter the incidence of hyperthyroidism the immediate postoperative complications and the mortality rate together with the cause of death in 21 cases in a group of 1,086 patients operated upon with partly or completely intrathoracic goiters.

FROM THE STÄRSÖ COAST HOSPITAL, GÖTHEN-BURG

INTERPOSITION OF OS PURUM IN OSTEOSYNTHESIS AFTER
OSTEOTOMY RESECTIONS OF BONES AND JOINTS
(INTERPOSITION-OSTEOSYNTHESIS)

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IN a recent article¹ entitled "Osteoplastic Cuneiform Osteotomy in the Treatment of Ankylosis," I explained how fairly large sized pieces of boiled autoplasmic bone heal in when transplanted in connection with an osteotomy affecting the diaphysis or the epiphysis. The characteristic features of the healing in process, which was observed by means of a series of roentgenograms taken at intervals and as long as 465 days after the operation, were (1) that the boiled bone grafts healed in primarily, (2) that they appeared to be able, without collapsing to support the mechanical strain to which they were subjected, and (3) that the regeneration of bone in the epiphyseal transplants was endosteal, i.e. regeneration took place within the graft, whereas in the diaphyseal transplantations regeneration of bone was mainly periosteal in that the newly formed bone developed to a great extent beneath the periosteum outside the graft. I also pointed out that as centrally located minor necroses remain for some time in the higher and bulkier parts of wedge shaped grafts, it should be advantageous to use graft material free from connective tissue, albuminous substances and fat, os purum, so that the canal system of the bone would thus be more easily accessible to the living cells which grow into the canals from the surrounding tissue. I stated, too, that I was engaged in making surgical tests of such bone material.

The graft material I use is both homoplastic, obtained from amputations, and heteroplastic, obtained from the slaughter houses. In either case the material is immediately freed of soft parts and is then subjected to a very lengthy chemico-physical process of purification, the fat, albuminous substances, and connective tissue being dissolved and extracted, so that the canal systems in the lime residue remain open. We have kept this graft material in a dry condition in sterile glass vessels for longer or shorter periods of time before using immediately before use the material needed is boiled for about 10 minutes in a physiological salt solution. Such graft material

is easy to manipulate for surgical purposes. It is porous and its open canal system makes easy the absorption of blood and tissue serum when the graft is implanted in the tissues.

In this paper I shall describe the technique and instruments used in these bone transplantations, and will show roentgenograms of some cases in which I have employed these grafts. In my contribution entitled "Studien ueber Knochenimplantation und Knochenneubildung. Implantation von os purum sowie Transplantation von os novum," I have described the process in detail.

In an epiphyseal cuneiform osteotomy it has been found very easy (1) to secure fixation of the bone wedge because of the friction of the spongy surfaces and (2) by means of the graft, to retain the ends of the bones in good position in relation to each other. In a diaphyseal osteotomy however, it was—as I have also found in subsequent similar operations—difficult to keep the graft in position because of the hard, smooth surfaces of the bone, the ends of which easily slipped in relation to each other.

I have for this reason, especially as it affects the diaphyseal operations, elaborated the operative technique and shaped the graft so that when it is feared the bones may slip in relation to each other the graft by its very form will remain in place between the ends of the bones and fix the bones in relation to each other without thereby adversely affecting the action of the bone generating tissues. For instance, if the graft is shaped like a sphere is of suitable and proper size, and is inserted exactly between the ends of the bone after an osteotomy or after a transverse fracture of the long bone, it will partly penetrate into the medullary canals of the respective ends of the bone and will be kept in position by the action of the surrounding, contracting musculature. By this means the ends of the bone will also be kept in the desired position in relation to each other. Such an interior fixation becomes effective if the movements between the ends of the bone are further more fixed in the usual way by means of externally applied surgical or orthopedic fixation devices.

The insertion of the graft between the ends of the bone after an osteotomy, the resection of bones, or the like may cause trouble and difficulty. It is difficult with the customary surgical instruments to distract in a longitudinal direction the ends of the bone of the extremities. If, however, one makes use of a distractor which I have designed for the purpose, the procedure will very likely not entail any great difficulty. At one end this instrument is shaped like a chisel, the other end is provided with a transverse handle (Fig. 1). The edges of the chisel end are faceted like a prism, they are meant to give support and, when pressure is applied, to grip the ends of the bone without slipping on them. To produce distraction the chisel end of the distractor is inserted between the bone fragments of the osteotomy, fracture, etc. (Fig. 2 a). When a suitable position in relation to the bone fragments is reached, the instrument is rotated upward by a quarter turn around its longitudinal axis, thus the ends of the bone are separated from each other the breadth of the chisel end (Fig. 2 b). Thereupon the graft, which has been suitably shaped before the operation as determined by the roentgenograms, is inserted between the ends of the bone by means of a pair of fenestrated angular tongs, or the like, after which the chisel is rotated back and is withdrawn. The muscular tonus now forces the ends of the bone together, so that the graft is partially surrounded by the medullary canals, thus locking the ends of the bone together.

However, should the width of the chisel of the distractor be insufficient to achieve the necessary space between the ends of the bone, another distractor with a broader chisel end must be taken and inserted beside the previous one and rotated so that a greater distance between the ends of the bone may be obtained. With a series of distractors with chisel ends of different breadths (Fig. 1), the operator will be prepared for such eventualities. This method is best suited for operations upon the epiphyses. Care should be used when rotating the distractor to protect the spongy part by means of thin bone or steel spatulas (Fig. 6) which serve as protection between the instrument and the bone, and also as gliding surfaces for the roughened spongy graft. Manipulation of the extremities is also of assistance in inserting and adjusting the graft. Finally if it is found necessary a lever, a 'guide lever' designed by me can be used. By means of this lever one of the bone fragments together with the graft fitted into the medullary canal in the course of levering up is pushed and guided against the other fragment (Fig. 3). This last mentioned

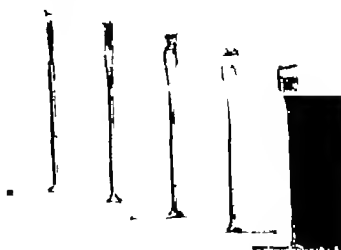


Fig. 1. Series of distractors with various breadths of chisels.

method is often found suitable in diaphyseal operations.

If, now, a spherical graft has been adjusted between the ends of the bone in such a way that it projects for some distance into the medullary canals on either side, the ends of the bone can afterward not be dislocated laterally but easily toward the periphery and axis if the sphere is sufficiently large. Dislocation longitudinally is prevented, after the adjustment of the graft, by muscular tension. Such an osteosynthesis will, therefore, form, and the bone fragments during the ensuing fixation treatment can be conveniently adjusted in relation to each other.

In osteosynthetic treatment of fractures, the method here described might be used when dealing with transverse fractures of long bones, and in the case of other minor oblique fractures. In very oblique, or in spiral fractures, or in fractures in the epiphyses, the synthesis must be carried out in some other way, preferably by the use of ordinary bone pegs, tongue shaped or lamellar pieces of bone, in combination with uniting sutures. The bone peg and tongue shaped or lamellar pieces of bone are driven into holes, drilled into the compact mass in several places, or into grooves cut with a circular saw, or direct into the spongy mass, so that a dislocation lateralward and toward the periphery is prevented.

The bone pegs should be shorter than the breadth of the chisel end of the distractors, so as to enable the pegs to be easily interposed by means of the distractor.

I have carried out osteotomies by drilling holes through the bone in one and the same plane, and then breaking the bone through in this plane by means of a chisel. For boring these holes I have



Fig. 2. a, left. The distractor is inserted between the ends of the bones. b, The distractor after rotation.

employed the very perfect drilling machines used by dentists. The shanks of the drills in these machines are extremely light and easily manipulated and can be had in angular shapes, an advantage, especially when canals have to be drilled in the longitudinal direction of the bone stems.

I have likewise designed a special instrument for carrying out boring operations. In this instrument the ordinary straight shank is inserted into a guiding device designed so that the shank and drill are guided in such a way that the holes drilled through the bone will be radially in one and the same plane (Fig. 4). By means of a specially shaped chisel with an angular edge the angle-osteotomy (Fig. 5) the bone is cut through in the plane of the drilled holes. The ends of the bone cut through thus have uneven surfaces and this factor may be of advantage when

carrying out distractions. Moreover the soft parts can be better preserved by this method than if the Gigli saw is used. The drilling apparatus makes only very slight movements in the soft parts, and in view of the ease and facility with which the shank can be handled, the hand quickly and easily senses when the drill has passed through the walls of the bone, so that the drill can be withdrawn before it has had time to injure the soft parts. In this form of osteotomy the periosteum need be removed only on that side which faces the wound and the marrow is not destroyed since the material inserted enters the medullary cavity only slightly and cannot very well injure the endosteum. If the graft is spongy this will facilitate the growth of the vesiculated connective tissue.

The aforesaid drilling machines are, as is well known, driven by electric motors, which are very highly perfected for their purpose. They are extremely reliable, run almost noiselessly and are powerful enough for drilling into bone. They can also rotate the drills in either direction, so that, if these get stuck in the drill hole, they can be easily released. For the shanks I have designed drills of a particular type, with the cutting edge ground into milling cutters (Fig. 4).

In my research in grafting I have come to the conclusion that, in transplantation operations, soft tissues should be treated with the utmost care, since it is these tissues that produce the new bone and give it nourishment. The soft parts are therefore, kept apart by specially designed straight obtuse angled bone spatulas (Fig. 6) the periosteum being removed from the bone to a very slight extent. The periosteum should, first of all, not be separated from its own soft tissues, which convey nourishment, and the marrow should be protected to the utmost possible degree.

The sphenical graft can easily be made and standardized. The bone graft can also be made lentil shaped, conical, discoid or meniscoid, or it



Fig. 3. a, left. Guide lever. An instrument resembling a mortise chisel, bow shaped cross section and chisel shaped at the end. b, After the graft has been fitted into the medullary canal of one bone end, it is guided by means of a leverage movement of the guide lever toward the medullary canal of the other bone end.

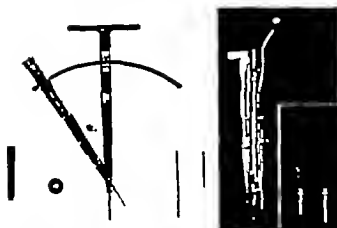


Fig. 4. Guide mechanism for the handle and drill. All the necessary parts are shown in the figure. The drills are of special design.

may be grooved or of an altogether irregular shape and yet fulfil its purpose of uniting and keeping together the ends of the bones. Some times it may happen that one cannot determine the shape of the graft until the wound is open. For that reason a so called technique motor, used in dentistry, provided with a circular saw and milling cutter specially made for that purpose should always be at hand. Even mortise chisels and vices, suitably fitted up on a table or bench should be available. If these tools are at hand, and if one has become familiar with their use, the operations will not be difficult to carry out.

The tools and instruments mentioned are practicable and necessary also in other forms of bone implantation and bone plastic surgery.

The risk of pseudarthroses exists, of course, in this as in other methods, but very likely the risk is less since a lateral displacement of the ends of the bones is here more safely prevented. To diminish the risk of pseudarthrosis arising the external fixation, which is meant to prevent any movement between the ends of the bones in other directions, must be effective for about 10 weeks after the operation. During this period the new bone, as a rule, develops enough to obtain sufficient strength. The occurrence of infection during operation must be excluded with absolute certainty.

CASE 1. No. 6633. Youth, 17 years of age. September 9, 1931, patient had a resection of the ankle joint for tuberculous of the ankle. At operation the resected bone was replaced by a disc of os purum spongiosum, which was inserted between the resection surfaces. The wound healed *per primam*. The patient was allowed to get up 3 months after operation, with a plaster-of-Paris cast. February 29, 1932, a leather bandage was applied. This was removed on August 1, 1932. Good functional and anatomic healing was present. To assure that the implanted bone disc did not collapse, a bone pin of a less



Fig. 5. Angular osteotome. The angular edge points downward, the handle upward.

easily dissolvable material was driven in, at the operation, frontally through the fibula and talus (Figs. 7 and 8). As is seen, the bone pin is neither bent nor fractured.

CASE 2. No. 6637. Boy aged 13 years. Patient had suffered a tuberculous coxitis which had healed with Bexion and adduction contractions. August 4, 1932, a subtrochanteric osteotomy was done. The ends of the bones, on osteotomy, were united by inserting by means of the "guide lever," a sphere of os purum compactum into the medullary canals of the ends of the bones. Roentgenograms, taken 97 and 295 days after the operation (Fig. 9), show that the healing of the bone is extremely good peripherally around the sphere, and that the latter is being gradually resorbed.

CASE 3. No. 6840. Man, 37 years old. December 22, 1931, a resection of the knee joint was done for tuberculous. After resection, the ends of the bones were joined together by driving in a tongue shaped piece of os purum (Fig. 10, 1). Primary healing took place. According to roentgenograms taken 610 days (1 year 8 months) after operation, progressive anatomical transformation of the graft has taken place (Fig. 10).

CASE 4. No. 6846. E. B. girl, 13 years old. The diagnosis in this case was genu varum after tuberculous coxitis. March 18, 1933, operation consisting of osteotomy infracondylar tibiae and bone grafting was done. After an ordinary cut in the soft part was made, the osteotomy was performed by means of a drilling apparatus and angle osteotome. The bone ends were parted with a distractor and small bits of os purum were interposed between the medial parts of the bone ends, so as to obtain the proper position between them. The periosteum was

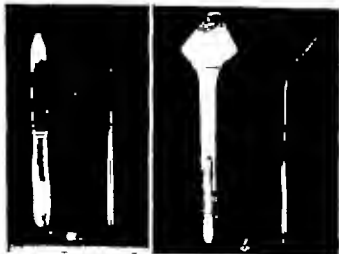


Fig. 6. a, Straight steel spatulas; b, Obtuse angled steel spatulas.



Figs 7 and 8 Roentgenograms in Case



Fig 9 Roentgenograms in Case 2



Fig 10 Roentgenograms in Case 3.

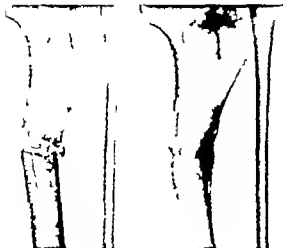


Fig 11 Roentgenograms in Case 4

sutured, and also the other soft parts. A fenestrated circular plaster-of-paris cast was applied around the thigh, shin, and foot. Primary healing took place. After 8 weeks the patient was able to be out of bed with a plaster cast on. Figure 11 shows roentgenograms on the day after the operation and 30 days (about 6 1/2 months) after the operation.

SUMMARY

"Interpositional osteosynthesis" aims at the restoration of bone in defects: the result of osteotomy, resection of bones and joints, fractures, etc. For this purpose bone grafts, specially shaped so as to prevent or impede lateral or longitudinal dislocation between the bone ends, are used. Dislocation toward the axis and periphery is, as a rule, prevented by externally applied surgical or orthopedic fixation devices.

As interpositional material bone is used which, by a special technique, has been properly freed of the soft tissues. This bone I have called *parvus*. The graft may be made any shape—spherical, lentoid, conical, discoid, clavate, linguiform, or any irregular form or shape.

Osteosynthesis is carried out by means of instruments especially designed for bone grafting. Among others there are the distractors, guide levers, bone spatulas, and specially arranged drilling machines similar to the type employed in dentistry.

Osteotomy is performed by means of a specially designed and constructed osteotome. "The angular osteotome" after the bone has been pierced in several places, is driven through the bone. With a guiding apparatus designed for shank and drill the holes are made radially in one and the same plane through the bone.

In the cases in which the method has been used the healing of the wound has been primary, and the bone grafts have been found capable of supporting, without collapsing, the mechanical strain to which they have been subjected. Moreover the roentgenograms show that the epiphyseal grafts after 200 to 300 days after implantation begin to show signs of newly developed bone structure, and consequently, of reconstruction of bone, whereas the diaphyseal grafts, which are inserted into the medullary canal, sequester and dissolve after a comparatively short period of time has elapsed while the regeneration of bone

proceeds mainly between the ends of the osteotomized bones.

As in the comminuted fracture, a fragment of bone may prevent reposition and cause the fixation of the ends of the bones in a wrong position so it is possible, by means of interposition in osteotomy in bone and joint resection, in fracture, etc., to obtain reposition and fixation of the ends of the bone in a calculated predetermined position. This is of importance, especially in those cases of osteotomy in which fixation after reposition is frequently never obtained or is accomplished only with great difficulty merely by aids.

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BENIGN STRICTURE OF THE INTESTINE DUE TO IRRADIATION OF CARCINOMA OF THE CERVIX UTERI

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IN a series of 452 patients with cervical carcinoma who have received irradiation therapy at the Cleveland Clinic, there have been 6 cases (incidence 1.4 per cent) of benign stricture of the intestine which might easily have been confused with metastatic carcinoma. Subsequent to the irradiation therapy no evidence of carcinoma was found, and judging by present day standards, none of these patients received excessive irradiation. Since similar methods of irradiation therapy are in general use, it seems probable that the incidence of this lesion is greater elsewhere as well as here, than the literature would lead one to believe. And if similar cases have been attributed to metastases in the past, the mortality statistics relating to metastases from cervical carcinoma are open to question.

The present study directs attention to this benign lesion as a clinical entity and offers suggestions for its prevention, the results of which will be reported in a later communication.

It should be emphasized that a patient who develops unusual abdominal symptoms, particularly if they simulate intestinal obstruction several months or even years following irradiation therapy may have an irradiation stricture of the intestine and may be restored to normal health by a resection of the lesion. Before the disability is attributed to metastases a re-examination should eliminate the possibility of this curable complication. At least sigmoidoscopic and colon roentgen examinations should be done, and a careful roentgen study of the small intestine may be advisable, provided the obstruction is not complete. Exploratory operation is warranted, particularly on patients presenting evidence of intestinal obstruction in whom there is no remaining evidence of carcinoma in the pelvis.

Of the 6 cases reported here, 5 of the benign strictures occurred in the sigmoid colon and 1 in a lower loop of small intestine.

CASE REPORTS

CASE 1. A woman, aged 60 years, when first examined, had carcinoma of the cervix uteri (stage 2) extending to the broad ligament. Biopsy showed that the growth was a squamous cell carcinoma, and the patient was treated by irradiation with radium and roentgen rays.¹

One tube containing 170 milligrams of radon was inserted into the cavity of the uterus and cervical canal for 4 hours, producing a total dose of 1,360 milligram hours. Three days later roentgen therapy

Follow-up examinations had shown no evidence of malignant disease and the patient had been in excellent health for over 5 years after the last radium treatment. Then she began to have unusual constipation, which became progressively more severe, and at the time of readmission, a few weeks after its onset, she had symptoms and signs of intestinal obstruction. Proctoscopic examination was negative, and no blood or mucus was seen in the bowel. Roentgen examination of the colon revealed an obstructing lesion in the sigmoid colon, which was believed to be due to carcinoma (Fig. 1). At operation, the lesion was found to have the characteristics of a benign stricture. There were bands of adhesions encircling the sigmoid colon at the site of the lesion and these were attached to the fundus of the uterus (Fig. 2). The adhesions were severed, this portion of the colon was resected, and an end-to-end anastomosis was made. The pathological diagnosis was chronic inflammation. The patient recovered well from the operation, and has reported normal health on numerous occasions during the 3½ years since the resection was performed.

CASE 2. The patient, aged 52 years, had had a pelvic abscess years previously and came to the Clinic because of pelvic symptoms. The cervix uteri was firm, enlarged, and nodular especially on the right side, and bled easily. There was no thickening in the broad ligaments. Squamous cell carcinoma was revealed by biopsy and radium and roentgen irradiation therapy was administered.

For a year and a half after the irradiation therapy follow-up examinations had shown no evidence of disease, and the patient had been in excellent health. Then she started to have severe pain in the bladder associated with some blood in the urine. These symptoms persisted for 3 weeks. Cystoscopic examination when the patient returned to the Clinic, revealed several submucous hemorrhages on the posterior wall of the bladder in the center of which was a white, irregular area about 3.5 centimeters in diameter. Subsequent examinations showed the development of a definite ulcer in the irregular area mentioned. One year following the initial cystoscopic examination, the ulcer had disappeared completely except for a small area of submucous hemorrhage due to separation of the slough a few days previously.

Approximately 1 year and 9 months subsequent to the irradiation therapy the patient began to have unusual abdominal symptoms, simulating intestinal obstruction. Roentgen examination of the colon showed no obstruction at the time of the onset of these symptoms. No further roentgen studies were made. The initial attack soon subsided, but a month later there was a recurrent attack which was more severe, and operation was performed.

Two months later second radium treatment was administered in the cervix, 220 milligrams of radon in four tubes being placed against the cervix for 10 hours, totaling a dose of 2,200 milligram hours, or total for the two radium treatments of approximately 3,400 milligram hours. The actual amount of radon delivered represents about 3 per cent less than these figures, when calculated according to the time the radon is in place.

Two tubes containing 304 milligrams of radon were inserted into the uterus and cervix and two tubes containing 120 milligrams of radon were placed against the cervix for 4½ hours, producing a total irradiation of approximately 370 milligram hours. Twelve days later roentgen therapy was started.



Fig. 1. Example of benign stricture of sigmoid colon simulating annular carcinoma.

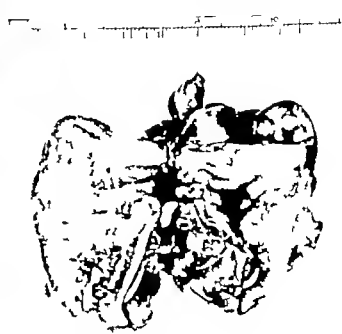


Fig. 2. Pathological specimen showing benign stricture of sigmoid colon. (Case 1)

There was an old inflammatory process in the uterine tubes, but no evidence of carcinoma could be found. About 25 centimeters proximal to the rectum there was a definite, almost complete obstruction of the sigmoid colon. It seemed as if there were a cocoonal band in the bowel wall, with very little inflammatory reaction outside. Resection was considered, but it was deemed more advisable to make an anastomosis around the obstruction, particularly in view of the fact that the sigmoid colon was unusually long. A side-to-side anastomosis was done. The last follow-up letter from the patient, 5 years after the operation states that she is in normal health.

CASE 3. The patient, aged 58 years, had a carcinoma of the cervix uteri, involving chiefly the posterior lip and the posterior vaginal wall (stage 2). The pathological diagnosis was squamous cell carcinoma. Radium therapy was followed by roentgen irradiation.¹

For 5 months the patient showed satisfactory progress, but did not return for the usual subsequent examinations. Later in a letter from the patient's husband who was a physician, it was learned that the patient had been confined to bed for a month because of abdominal pain, nausea, and pronounced vomiting. Examination revealed no evidence of carcinoma in the cervix or in neighboring structures. Death followed 1 month later. Complete autopsy was not permitted but examination of the abdominal contents revealed an inflammatory stricture of the lower small intestine, causing a definite obstruction. The exact relation of this area to the uterus was not stated, but examination of this area of the intestine and the uterus, after removal from the abdomen, revealed adhesions on the peritoneal surfaces of both.

From these findings it may be inferred that the stricture of the small intestine involved an area adjoining the uterus,

that fibrous adhesions formed between the two and that the cause of death (since no other cause was considered or found) was severe toxemia resulting from small intestinal obstruction.

CASE 4. The patient, 41 years of age, had an enlarged cervix uteri which was bleeding and ulcerated. The principal involvement was inside the cervix, extending into the uterus and outward through the cervix, lateral to the external os (stage 1). The biopsy showed squamous cell carcinoma. Radium and roentgen therapy was administered.²

The usual transitory sequelae immediately following these treatments were prolonged in this case. For 6 months, the patient complained of loose stools containing unusual quantities of mucus. The following month there was marked constipation, and after a period of 21 days without a stool, the patient suffered from considerable abdominal distention, and was re-admitted to the hospital with a diagnosis of intestinal obstruction. Follow-up examinations had shown no evidence of recurrence of the malignant growth in the cervix and no evidence of pelvic metastasis. Proctoscopic examinations had shown no evidence of disease. Laparotomy was not done at this time because her symptoms were relieved by the use of enemas and hot fomentations to the abdomen.

She was re-admitted to the hospital at 3 and 6 month intervals subsequently. An attempted barium enema was expelled as soon as it had reached the sigmoid colon, apparently indicating obstruction at this level.

A colostomy was done and a large tube was inserted into the dilated ascending colon for irrigations, 15 months after irradiation therapy. Later a colon roentgen examination during which the barium suspension was injected through the colostomy tube, revealed a definite obstructing lesion in the sigmoid colon. At the subsequent operation,

¹One tube containing 118 millicuries of radon was placed in the cervix, and another tube containing 177 millicuries of radon was placed against the posterior lip of the cervix, for 10 hours, or a total of approximately 3,650 millicurie hours. One and a half months later roentgen therapy was administered.

²One tube containing 106 millicuries of radon was placed into the fundus of the uterus, one tube containing 147 millicuries of radon was placed in the cervix, and four tubes containing 143 millicuries were placed against the cervix, for 8 hours, or a total of approximately 3,900 millicurie hours. One month later roentgen therapy was administered.

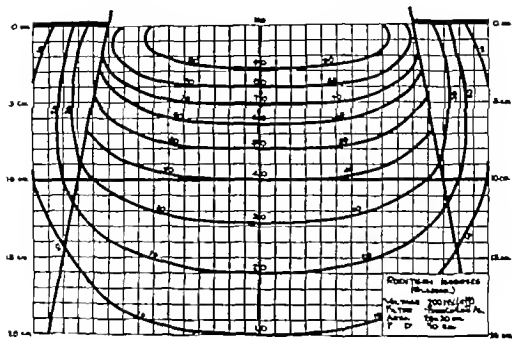


Fig. 3. Isodose chart (Glaser) showing depth penetration of roentgen radiation.

the time of the radium irradiation remains constantly in one position, adjacent to the area being treated, the lesion should be prevented if the position of this segment can be changed at intervals during the time the radium is in place. Changing the position of a lower loop of intestine without dislodging the radium may be difficult to accomplish.

During roentgen examinations, the position of redundant loops of intestine change appreciably when the position of the patient changes. The most pronounced alteration is observed during the examination of a freely movable redundant

sigmoid colon, when the patient is moved from a horizontal to a Trendelenburg position. Changing the position of the patient at intervals during the time of the radium therapy should prevent overirradiation of any one redundant segment of intestine, unless that segment is fixed in position (pelvic inflammation?) at the time of the irradiation. The radium inserted into the cervical canal would not be dislodged during such a procedure, provided the usual thorough packing of the vagina were done. The procedure would seem to be especially indicated when the radium is inserted high up into the fundus of the uterus. When the radium is placed against the cervix or inserted into the cervical tissue (needles) keeping the patient in a constant moderate Trendelenburg position would aid in the maintenance of the proper position of the radium, and at the same time should allow sufficient area between the radium and the intestine to prevent the development of the lesion under consideration. If the intra-uterine application of radium is made separately and not when other types of applications are made, the maximum prevention should be possible, so far as changing the position of the patient during radium therapy is concerned.

If continued peristaltic activity of the intestine could be obtained during the time of irradiation therapy this also might be a means of changing the position of redundant loops of intestine. A

TABLE I

	Cervix	Glans, 4 cm from cervix	Rectum, 4 cm from cervix
Field 1 (Suprapubic)			
Skin dose	700 r	700 r	700 r
Depth	40 r	40 r	30 r
Depth dose	250 r	250 r	210 r
Field 2 (Right iliopectic)			
Skin dose	400 r	400 r	400 r
Depth	25 r	25 r	30 r
Depth dose	100 r	100 r	120 r
Field 3 (Left iliopectic)			
Skin dose	400 r	400 r	400 r
Depth	40 r	35 r	30 r
Depth dose	160 r	140 r	80 r
Field 4 (post-sacral)			
Skin dose	800 r	800 r	800 r
Depth	40 r	40 r	55 r
Depth dose	320 r	320 r	440 r
Total depth dose	800 r	840 r	850 r

medicament such as pitressin, administered after the usual preparation of a thorough emptying of the intestine, might produce the desired effect. Keeping the tip of a flexible colon tube in the sigmoid colon (analogous to the usual procedure of keeping a catheter in the bladder) during the time the radium is applied in the attempt to prevent any accumulation of gas in this area might also be helpful.

CONCLUSIONS

1. In a series of 422 cases of cervical carcinoma in which irradiation therapy was administered 6 patients presented the late complication of a benign stricture of the intestine. These cases might easily have been attributed mistakenly to metastatic carcinoma.

2. A patient having this lesion may be restored to normal health by surgical intervention.

3. A colon roentgen examination was the most

important single pre-operative diagnostic means of revealing the presence of the sigmoid lesions.

4. It appears logical that this complication may be prevented without altering the principles of the well proved present day efficacious irradiation therapy of cervical cancer. This rare complication (incidence 1.4 per cent in this series of cases), when treated so successfully by surgical intervention, should not constitute a retarding influence on such therapy.

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VASCULAR DISEASE OF THE LOWER EXTREMITIES¹

A REVIEW OF AMPUTATION CRITERIA

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AMPUTATION criteria have been fairly well established for those emergencies which threaten the life of a previously normal limb. Prosthetic, mechanical, bacterial, neurogenic, hormonal, and direct traumatic factors as well as the acute vascular changes are all taken into consideration. When proper evaluation of each has been made, a decision as to the appropriate time, manner, and level of amputation can readily be reached.

The problem is more difficult however when it involves a limb already the seat of vascular disease. Here in addition to evaluating all the factors mentioned, an appraisal must be made of the extent of vascular damage previously incurred. The amount of collateral compensation for this damage must be discounted, and the remainder (which represents the true vascular deficiency) added to the limb risk.

This is not an easy task. But some assistance is rendered by what modern knowledge offers covering the pathogenesis and progress of vascular occlusion in these cases and by a multiplicity of clinical tests which offer at least inferential evidence of the vascular condition of the extremity. An analysis of the problem in the light of this knowledge and with the aid of some of these tests, it was thought might be of some value in helping define the amputation criteria in these cases.

THROMBO-ANGITIS OBLITERANS

Thrombo-angitis obliterans is an inflammatory condition of vascular walls, of unknown etiology, associated with the formation of occlusive thrombi. As yet there is no proof that any specific bacterium or toxin is involved. Neuburger in fact explains the entire pathogenesis of the condition on the basis of Rucker's hypothesis. According to this hypothesis, whatever noxi are responsible for the disease act by setting up local neurovascular instabilities. Arterioles spastic crises end in paralysis and dilatation with slowing of the blood stream. The various organic changes in the vessel walls are secondary to varying degrees of retardation of the nutritional flow. On this basis, in pathogenesis, at any rate thrombo-angitis is only a slightly milder but more tenacious Raynaud's disease.

The disease appears and subsides. The vessel wall changes and occlusive thromboses which before long result, are closely followed by the canalization and organization of the thrombi and by the opening up of collateral channels. The amount of actual vascular deficiency which remains, depends on the relative speed of the two processes (10 37 38 46 51 57).

The disease is usually slow in its progress. It occurs characteristically in relatively young individuals who start with an ample capacity for the development of collateral circulation and for the thrombus re-canalization. The disease process, it self, interferes in no way with the development of collaterals. At the onset at least, it is limited and focal in its attack so that only short segments of thrombi have to be re-canalized and only short collateral circumductions provided. Compensation is readily made. As the attack subsides, circulatory efficiency is re-established with only a slight withdrawal from the available collateral supply. At best, however the disease is remittent. With each attack, more of the main channels are occluded and more of the collateral channels are opened up. With its varying intermissions, the disease progresses relentlessly. With each attack, the margin of safety shrinks. Yet if the process be slow enough and the patient young, the main channels may become totally occluded and the life of the limb be maintained by the extensive opening up of collateral channels characteristic of this disease. Barely enough blood flows, however through these vicarious channels to maintain life in the part. The demand for more blood under exercise of the limb finally cannot be met and ischemic cramps hinder activity. The increment required for the healing of minor wounds cannot be supplied and they fail to heal. With all collaterals widely dilated, further circulatory damage cannot be compensated and gangrene develops.

Sometimes the disease takes a more rapid course. Attacks of migratory thrombophlebitis follow closely one upon another with short or no healing intervals. Sometimes it starts in older individuals or is complicated by arteriosclerosis. Under these circumstances, little collateral compensation develops and even less extensive vascular occlusion can quickly lead to gangrene.

From the Department of Surgery of Northwestern University Medical School. Study made on patients of Cook County Hospital and Wesley Memorial Hospital. Read before the Chicago Surgical Society, March 4, 1934.

The disease is nearly always bilateral. When manifest in only one leg it is almost certain to be latent or potential in the other, and sooner or later, may be expected there also.

When the question of amputation is raised, the first problem is to determine just how extensive the arterial blockage has been and how extensive the collateral circulation in compensation. This may be determined by various clinical observations and by certain special tests. There is no absolute criterion of the circulatory efficiency of a limb but by a combination of several different types of observation a fairly reliable estimate may be obtained.

From an accurate history alone some inference can be drawn concerning the circulatory condition of the limb. The age of the patient gives the likelihood for complication with arteriosclerosis and some idea of the collateral potential. The duration of symptoms and the relation of periods of activity and attacks of thrombophlebitis with intervals of remission and recovery, give an account of the various inroads on the vascular supply, the extent of probable compensation, and the available collateral supply left. The severity of current symptoms is roughly proportional to the circulatory deficit.

The general appearance of the limb in the horizontal position is of some importance. To what level normal color is seen and the extent and intensity of anemia and rubor are to be noted. The general nutrition of the limb, the color changes of chronic stasis, scaling fissures, calluses, nail changes are all to be considered. All these denote total circulatory deficiency of which ulcers and finally gangrene are the end stages. The extent of the gangrene and its demarcation are to be noted, but this observation is notoriously unreliable in determining the degree of circulatory deficiency of the whole limb (25). It only specifies the degree of local deficit. With a large area of gangrene, the rest of the limb may be fairly well supplied with blood. With little or no gangrene severe pain, color, nutritional and other changes may show the whole limb to be fairly devascularized. Usually sharp demarcation speaks for the excellent development of collaterals down to the level of gangrene (McLenny) but this sign of circulatory efficiency would be invalidated by infection. Finally the total extent of skin gangrene portrays only inaccurately the extent of deep gangrene which may be considerably greater or smaller.

Of greater importance than the simple appearance of the limb is the extent of the anemia which appears on elevation and the rubor which appears on dependency. The levels to which these rise are



Fig. 1. Normal leg. Vessels injected with barium sulfate under normal systolic blood pressure of the patient. Note smooth contour of main vessels and moderate collateral supply.

the levels of circulatory sufficiency under static strain. The intensity of these changes and the angle of circulatory sufficiency (Buerger) give a fair estimate of the degree of deficiency. These signs, however, do not determine the level of circulatory sufficiency under muscular strain. This can be inferred only from the symptomatology. Nor do they determine the circulatory sufficiency under the strain of healing. This can be guessed or determined only vaguely from the history of previous wound healing difficulties.

The level of abrupt temperature change is of great assistance. The limbs are left alone for 15 minutes, then covered with the bed clothes for 15 minutes (58). There is a normal acralward gradual decrease in skin warmth but there is never an abrupt change unless there has been vascular occlusion without adequate collateral compensation. The temperature change level may be determined roughly by the hand or by a clinical skin thermometer or more accurately by the thermocouple (12).

These observations as well as most of those which follow, record the total circulatory status, i.e. vascular obstruction minus collateral compensation. The level of actual main vascular obstruction.

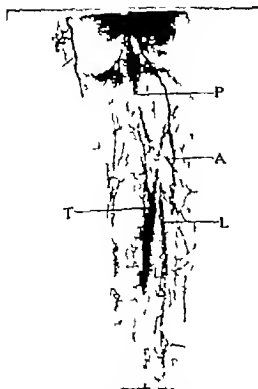


Fig. 2 Case of thrombo-angitis obliterans. Showing the patchy irregularities along the popliteal, P and anterior, A and posterior T tibial arteries, and the large and numerous collateral vessels. The peroneal artery L, is well preserved and larger than normal. (Photograph loaned by D. Frank Bleikney)

tion can be estimated by palpation of the main vessels. Routinely the dorsalis pedis, posterior tibial, popliteal, and femoral should be palpated.

It is possible, however for all these vessels to be pulsatile, yet an early Buerger's disease be detectable in the plantar vessels by plantar anesthesia on elevation. Circulatory deficiency should not be dismissed on the basis of pulsatile vessels.

The chief difficulty with this palpatory sign, however is that the main vessel pulsations are accessible to tactile perception only at a few widely separated points about the main joints. To obviate this difficulty and to obtain a more quantitatively accurate estimate of vascular pulsation the Pachon oscillometer was devised (54 61 62). This may be applied at any segment of the limb and the total vascular pulsatility of that segment under varying external pressures determined and compared with the other limb or with the normal. At the level of main vascular occlusion there is decrease in the pulsation volume. This method unlike the tactile is not selective. The anterior

tibial artery may be occluded just above the ankle. Yet if the posterior tibial dilate sufficiently in compensation the pulsation volume may be maintained. Even smaller collaterals may compensate for the decrease in pulsation volume caused by occlusion of the main channels.

For these reasons except in acute vascular obstruction, the Pachon oscillometer does not determine the exact level of occlusion. Its accuracy is inversely proportional to the extent of collateral development. Usually there is some decrease in pulsation volume at or a little below the point of main vessel occlusion. Pulsation continues, however until the end of the pulsatile collateral supply is reached.

The oscillometer determines the level of pulsatile collateral supply. Beyond this level there is an oozing non-pulsatile collateral supply which the machine does not register. This occult circulation between O of the instrument and the total cessation of arterial flow may be observed by decreasing the bag pressure in the non-pulsatile segments until a dusky red blush appears. This represents the first escape of oozing blood (Simpson). The non-pulsatile flow may be rich enough to keep the tissues alive and even bear the strain of postoperative healing. It may permit amputation below the level of O deflection of the Pachon oscillometer.

To determine the extent of this non-pulsatile but adequately vascularized zone other methods are used. One of these is the McClure Aldrich intracutaneous salt solution absorption test (Stern and Cohn). 0.2 cubic centimeter of 0.85 per cent sodium chloride is injected at 4 inch intervals down the limb. Normally the wheel should remain for 60 minutes. In impending tissue edema induced by circulatory deficiency the absorption time is markedly reduced. The test is simple, painless, and gives a reliable estimate of skin circulation. It cannot be used where there is already an inflammatory static, or nephritic edema. Objections to it have been raised on the grounds that tissues which are the site of impending gangrene, should not be injured further by needle pricks. It does not seem that a hypodermic salt solution wheel would produce material injury.

Another similar method is the histamine flare test (30, 30). It depends on the universal anaphylactoid vasodilatory response, wherever there are capillaries to dilate. One-tenth cubic centimeter of 1:1000 histamine is injected intracutaneously at short intervals down the limb. There is at first a cyanotic flush then a hyperemic flare and finally wheal development. If at a certain level a flare does not appear amputation

must usually be done above this level. If a flare does appear (without regard to time interval) the skin circulation may be adequate for amputation, or may not be. The test has chiefly negative value, therefore, but is a good auxiliary sign. Clinically its results have been found to be more accurate than those of the McClure Aldrich test, but the injections hurt about as badly as a bee-bite. (Perlow has recently devised a method of rendering these injections painless. Novocain is added to the histamine solution to make a concentration of $\frac{1}{4}$ per cent. We have tried this method with gratifying results. The novocain interferes in no way with the test, and completely prevents the pain.) Both of these skin tests are open to the objection that skin circulation may not be an accurate measure of muscle and bone circulation. The deeper structures may be non-viable beneath a well nourished skin.

A direct study of the circulatory adequacy of the deeper structures may be obtained by the thermocouple and galvanometer method of Brooks and Jostes or by the calorimeter method of Stewart. These methods are too time consuming and cumbersome for routine clinical use.

X rays are taken routinely. They may disclose areas of osteomyelitis and reveal the amount of arteriosclerosis present. The latter factor is of only moderate value because extensive sclerosis may be present with adequate collateral circulation or slight sclerosis with inadequate collaterals. Although the vessels may be easily and plainly visualized by X ray, the degree of opacity to the X ray does not always correspond to the patency of the vessels themselves. Direct visualization of the circulation in the affected extremity by injection of radio-opaque substances has also been recommended (Singleton, Pearse 56) but is too heroic a method for general use. They are painful enough to necessitate nerve block anaesthesia for their induction. The effect of these substances on vessels already damaged by disease is not beyond suspicion. The Matas and Moskowitz tests of inducing hyperemic flush by temporary anemia are open to the same objections (40).

In 90 to 95 per cent of the cases simple clinical tests are sufficient to determine the level of adequate circulation. Palpation and the Pachon oscillometer determine the level of main vessel occlusion and the level of cessation of pulsatile collateral flow. The history of the case the severity of symptoms, the appearance of the limb when horizontal, the skin temperature change level and the histamine or salt solution tests give a fair estimate of the level to which the non-pulsatile collateral flow has been developed. Rubor on



Fig. 3. Arteriosclerotic gangrene. Vessels injected. Note beading and irregularity of main vessels and paucity of collateral channels. Patient 64 years old.

dependency and anemia on elevation estimate the adequacy of the collateral circulation to static strain. The reaction of the limb under muscular activity gives an estimate of its adequacy under the strain of muscular exercise. The response of minor lesions to conservative treatment gives some estimate of the capacity of collaterals to provide for healing.

With the total decrease in circulatory intensity determined, an estimate must be obtained of the amount of this decrease which is spastic and the amount organic. On this depends in some measure the types of pre-amputation procedures instituted. The spastic element may be differentiated and evaluated by instituting measures which paralyze vasomotor constriction (6 13 18 21 22 48, 49). This may be done by immersing the part in a warm bath, by inducing a general fever with killed typhoid bacilli intravenously by paravertebral block, spinal anaesthesia, general anaesthesia peripheral nerve block or diathermy application to the cervical or lumbo-sacral regions. Of these, the best and most widely used method is that of



Fig. 4. Diabetic gangrene in a young adult. Note the beading and irregularity of the main vessels, but the super-normal richness in collateral development. The gangrene of the anterior third of the foot which developed here was on an infectious basis and did not depend on circulatory defect.

peripheral nerve block. The rise of local skin temperature (and the increase in oscillometric excursion) after anesthesia is an index of the amount of vasoconstriction responsible for the local circulatory deficiency. The remainder is the organic factor.

Before amputation is decided upon, unless the indication is urgent, some attempt should be made to improve the collateral circulation and to reduce the spastic element. Conservative management includes treatment of the local lesion, postural exercises (15), dry heat (60), saline or citrate solution in large quantities orally (32), subcutaneous oily intravenously or by duodenal gavage, diathermy and intermittent compression of the main artery. The diathermy should not be used in trophic disorders or gangrene. Other non-operative measures which have been employed are the intravenous injection of radium chloride (4), triple typhoid vaccine, typhoid "H" antigen (7) or

acetylcholine (70). In typhoid bacilli resistant cases, the injection of 2 per cent sulphur in olive oil intramuscularly has also been recommended (69).

Ligation of the femoral vein has been recommended (44, 71). Morton and Pearce (47) tried it in 6 cases. It improved the circulation, increased skin and muscle temperature, and reduced pain. In view of the fact that Buerger's disease involves the veins as well as the arteries, not much can be expected from this procedure. The same may be said for arteriovenous anastomoses.

In cases with a marked spastic element, various operations designed to abolish sympathetic vasoconstriction have been applied. The simplest of these, periaxillary sympathectomy was successful in a small percentage of cases (9). The vascular nerve supply is segmental. Not much, if any value can be expected from denervating a segment of artery when this disturbs but slightly the whole arterial tree beyond this segment. To meet this objection, more drastic denervation operations were tried which culminated in the operation of thoraco-lumbar sympathectomy with trunk resection (13, 14, 31). The operation is formidable. It gives good results in predominantly spastic diseases like Raynaud's disease and in early vasospastic scleroderma. It is too heroic an operation to be justified in early cases of Buerger's disease. The cases with frank gangrene do not permit the procrastination which this operation entails. It may be applied, however, to moderately advanced cases of Buerger's disease with a marked spastic element and without gangrene. The immediate results in well selected cases of this group are encouraging, but give no guarantee that the thrombo-angitic process will not proceed regardless of the operation, or that vasospastic control will not be regained through inoperable anastomoses from other parts of the sympathetic net or from local assumption of automaticity.

The simpler measures outlined when used to reduce the spastic element and to improve the collateral circulation are of great value in preventing gangrene or at least in increasing the amount of available stump. Applied after operation also they increase the chances of success of less drastic amputations. The use of these simple measures should be encouraged.

Buerger insists that none of the methods used for determining circulatory intensity determine the lowest level at which an amputation stump will heal that after the various conservative measures have been employed and amputation becomes imperative amputation above the knee is indicated in all but very exceptional cases.

Where possible he recommends the Gritti Stokes. Telford states that when gangrene threatens, the popliteal is almost always involved, and that to amputate lower than the knee is to court disaster. The recommendation of this high arbitrary level has met with growing disapproval. It has to recommend it the fact that re-amputations are avoided and that hospitalization is minimized. Further Buerger's disease is a progressive lesion and high amputation may anticipate its advance. On the other hand, these re-amputations are avoided at a great deal of needless mutilation. Hospitalization is minimized at the cost of a much greater post hospital disability. The progress of Buerger's disease is so erratic that no one can say when and where it will stop. It may end with low amputation. Midleg amputations are frequently adequate. This disease occurs in young men of working age who must stave off major disability as long as possible. There is always the prospect of serious involvement of the other leg therefore as much as possible of each leg must be spared. Finally re-amputation, except in cases of spreading infection or spreading gangrene, is of no very great risk in Buerger's disease and is often worth taking a chance on to avoid needless loss of limb.

Each case must be estimated on its own merits, and the lowest level of amputation compatible with healing and function selected. In 1913 Mc Kinley recommended that the diseased vessels be dissected upward until a point is reached where the blood supply appears to be satisfactory and that amputation be done at that level (8). The method was dropped because the difficulties and complications of the technique were too great to justify it and because it took no account of the collateral compensation. Meleney suggested that if popliteal pulsation were present, amputation could be done below the knee. A later review of his results made him feel less assurance in accepting this one finding as the basis of selection of the amputation level. Burke considered the patency of the femoral artery to be far more important than that of the popliteal. He found popliteal pulsation absent in 50 per cent of successful amputations below the knee. He stated that if a full pulsation of the femorals could be felt to 4 centimeters or more below the inguinal ligament amputation below the knee could be done even if the popliteal were closed.

As a matter of fact the selection of an amputation level cannot be based on any one criterion. The problem is too complex to be settled so readily. Allen and Meyerding reviewed 107 cases of amputation in Buerger's disease and suggested

some additional factors as of possible significance in selecting this level.

1. The age and general condition of the patient. They found that amputation below the knee would be successful in 80 per cent of the cases when the patient was under 45 and in good condition and there were no extensive local changes. Re-amputation would be necessary in only 50 per cent of cases fulfilling these conditions. They found that in older patients and with extensive local or septic changes, primary amputation above the knee was required.

2. The condition of tissues at the proposed operative site. Considerable muscular and skin atrophy would make the healing possibility unlikely.

3. Lack of economic urge. If the economic situation permitted prolonged treatment, small ulcers and small areas of gangrene often healed spontaneously and function was re-established.

They found that one of the important results of early diagnosis lay in not mistaking the pain and dependent rubor about the toes for a paronychia, and incising it. It is a simple matter to examine all feet routinely for a dorsalis pedis pulsation and for plantar anaemia on elevation. If this shows circulatory deficit in the toes, they should not be incised nor should toe nails be removed without careful study of the circulatory condition of the rest of the limb nor without careful surgical decision and thorough pre-operative and postoperative care. These indiscriminate incisions heal with great difficulty and may lead to spreading gangrene when operative trauma aggravates the vascular deficit and increases the healing load.

Amputation may be required even without any local lesion. With skin intact but with excruciating pain, which cannot be relieved by the medical management outlined, amputation at a proper level is justified.

The selection of an amputation level depends primarily in vascular diseases on the circulatory status of the leg and secondarily on infectious, mechanical, prosthetic and other factors.

Toe amputation will suffice in Buerger's disease if

1. The patient is under 45 and in good general condition

2. The local lesion is limited to a small ulcer or area of dry gangrene involving only one phalanx

3. The dependent rubor and elevation anaemia is restricted to the toes.

4. An abrupt temperature change level is absent down to the toes.

5. The dorsalis pedis or the posterior tibial pulsation is present

6. The oscillogram shows a fair total pulsation in the foot

7. The salt solution or histamine test is satisfactory at the level of the metatarsophalangeal joints

If the X-ray reveals the absence of a phalangeal osteomyelitis, and especially if the skin tempera-

ture rise after local nerve block shows a marked spastic element, conservative management should be instituted to reduce the spastic element and encourage collateral circulation development. If healing does not result after full benefit has been obtained from these measures, toe amputation may be done.

If more than toe amputation is necessary the next available level is midleg. Chopart and Paragoff amputations are not particularly satisfactory even in feet with normal circulation. Even the Symes amputation is losing favor (68). It is not done at all in women because the prosthesis necessary gives an ankle of abnormal thickness. It was employed for laboring men who had to stand on their feet all day because of its end bearing qualities. But circulation about the joints is not very rich at best. Bad experiences with *sloughing of flaps even in normal legs* and improvements in prostheses for the higher amputations have swung surgical judgment to the latter. The maximum length of leg stump practical is 7 or 8 inches. The lower third of the leg even with normal circulation has not a very good blood supply. A stump longer than 7 or 8 inches invites *sloughing* and is of no particular mechanical advantage (28, 53).

If the lowest judicious level of leg amputation even in normal legs is 7 or 8 inches below the tibial tubercle in Buerger's disease sufficiently advanced to require leg amputation, the amputation should be done somewhere above this level. Perfect collateral compensation for vascular obstruction cannot be expected. How high above this level one need go depends on the circulatory status determined. If the popliteal pulse is present or even with it absent, there are signs of good collateral circulation down to the lower third of the leg, midleg amputations can be done. The oscillometer should register good excursions at the level selected, or else the deficiency in pulsatile collateral flow must be compensated by evidences of an unusually good non-pulsatile flow. Anemia on elevation and rubor on dependency should not extend above the ankle. The temperature change level should be 10 centimeters below the midleg level. The salt solution or histamine tests must be positive at this level. If the patient be under 45, and the X-rays disclose no extraordinary arteriosclerosis and the area of gangrene and infection does not extend beyond the ankle, midleg amputation may be done. If these conditions are fulfilled and the area of gangrene is small but the infection extends to the lower third of the leg, midleg amputation can still be done if the open technique is used. In proportion as these condi-

tions are not fulfilled, higher amputations must be done keeping always well above the zone of static vascular deficiency, slightly above the temperature change level, and within the zone of good skin circulation.

Two inches below the tibial tubercle is about the shortest leg stump practical (27). Makers of artificial appliances say that fairly satisfactory service may be obtained even with a 1 inch stump. But the mechanical advantage of this small leverage must be rather slight. Further circulation close to the knee joint is not particularly good even in normal limbs. The healing power of a Buerger's disease leg which requires amputation at 1 inch below the knee is questionable. In many clinics, the high leg amputations have been replaced by the Gritti-Stokes. The Gritti-Stokes is end bearing. If it succeeds. The objection raised to it on the grounds that it elongated the thigh has been answered by the application of an underslung knee joint. The operation requires, however more manipulation and healing strain than these devascularized tissues can bear. It is end bearing only if the poorly vascularized skin can bear the strain of pressure. It is probable, therefore, that if a leg can stand a Gritti-Stokes, it can stand a lower amputation better.

The Gritti-Stokes may have an occasional indication. If it cannot be done, a supracondylar thigh amputation will serve just as well. The mechanical advantage is as good. The usual type of mechanical joint can be applied. Anatomical bearing shifts pressure from an end which needs all the circulation it has to heal and stay healed, to higher points near the groin, which are much better supplied with blood (55).

Amputation above the knee should be done if full femoral pulsation cannot be obtained to 4 inches below the inguinal ligament if good oscillometric excursion cannot be obtained just below the knee. If anemia on elevation and rubor on dependency extend well up the leg. If the temperature change level is just below the knee. If the salt solution or histamine tests are negative to the knee but positive above. If the patient is over 45 or there is extensive gangrene or infection. If these tests show circulatory insufficiency to extend even above the knee if the patient is still older the gangrene more extensive and the infection more severe amputation at midthigh is indicated. In all these operations, a proximal tourniquet should not be used. Use may be made of the distal tourniquet in order to prevent reflux. Postoperative care must include all measures which are available to develop collaterals and to promote healing.

ARTERIOSCLEROSIS

Arteriosclerotic vascular occlusion is an accompaniment of old age. The patients are in poorer general condition. Cardiac, nephritic, pulmonary and cerebral complications play a greater and sometimes the dominant rôle in the surgical picture. The cellular vitality, the lust for life of the tissues locally is reduced. They die easily, they heal poorly. The *Blutgefuehl*, the ability of the living tissues to attract vascularization, is diminished (11). The collateral potential is decreased.

The vascular involvement of old age is not patchy as it is in Buerger's disease, but uniform. It strikes not only one or two branches of the vascular tree at a time but the whole tree at once with all its finest twigs. When occlusion becomes manifest there are no entirely free channels which can open to take up the load. The margin of collateral safety is very small. The process, however, is slow. The duration of symptoms from their onset to the development of serious surgical situations necessitating amputation is very long except as sudden impulse is given to the occlusive process by infection or thrombosis. Except for these accidents the limb expectancy with proper care may be 5 or 10 years or longer from onset.

The disease occurs in patients who are usually beyond working age. The economic issue is therefore, not as pressing as it is in Buerger's disease. Working function in the limb is not as important a part of the amputation decision and temporizing is better countenanced.

The process is predominately degenerative rather than inflammatory or neuro-circulatory. In the muscular arteries of the extremities it begins as an increase in the mucinous metachromatic ground substance of the media, for it is the media which carries the burden of functional strain in these vessels. As the mucin increases, the elastic and muscle tissue of the media decrease. Fat deposits hyalin fibrosis sets in and is soon followed by calcification. Secondly the intima is involved first with fat deposit, then with intimal proliferation. The lipid is desmoplastic hyaline fibrosis becomes more and more marked. The fatty plaques within the thickened intima break down calcium is deposited and finally, ulceration develops. These intimal changes however, come on only long after the medial changes are well advanced. The patients generally do not have a high blood pressure. Those with high blood pressure usually can keep driving blood through the thickened vessels adequately until one of the hypertension accidents kills them.

A spastic element in the vascular occlusion is sometimes present. It is very variable. Just as in

Buerger's disease, it must be estimated and dealt with, but it is usually a small part of the occlusion problem.

Pain is a prominent symptom because of the high grade circulatory insufficiency. It alone may be indication enough for amputation. The blood supply may be worse in a painful leg without gangrene, than when gangrene is actually present. Gangrene is usually precipitated by thrombosis in the diseased vessel or by infection. If the superimposed injury is small, collaterals develop. They develop slowly and poorly in proportion to the patient's age, and not much can be expected from them. It takes months and years for them to develop but enough may develop to avert gangrene for many years even though pulsation be absent. When gangrene does supervene, limited amputation may suffice because of the collaterals even though pulsation be absent. If collaterals do not develop sufficiently, or if the thrombosis is more rapid or extensive or if severe infection supervenes gangrene results, before collateral circulation can replace the main channel flow and nothing but a high amputation will heal.

When the question of amputation arises, the circulatory status of the limb is determined just as in Buerger's disease. The Mats or Moszkowicz tests are not recommended because of possible injury to diseased vessels. Routine X rays are taken to determine the amount of arterial calcification but this gives only a vague estimate of the circulatory intensity. They take no account of the collateral development which, though usually slight, is sufficiently variable so that in some cases at least it will prevent needless loss of considerable limb length.

The history is taken, the severity of symptoms noted, palpation for pulsation, oscillometric excursions, the level and intensity of anæmia on elevation and rubor on dependency, the angle of circulatory sufficiency, the temperature change level, the appearance of the limb when horizontal the character of the local lesions and the salt solution or histamine tests are determined. Whatever spastic element is present is evaluated. Pre-operative management to reduce the spastic element and encourage collateral development is instituted for whatever benefit may accrue.

Amputation may be withheld for a long time unless there is evidence of spreading infection or a large area of gangrene or intractable pain. Conservative management including active and passive exercises, dry heat, hot baths, abundant fluids and some form of fever therapy, together with proper care of the local lesion along general surgical principles may suffice to heal recalcitrant

wounds or superficial ulcers or well demarcated small areas of gangrene at the tip of a toe, provided there is no gross circulatory deficit and infection is slight. The dorsalis pedis or posterior tibial pulse must be palpable, or if either is not palpable, adequate collateral supply must be shown by warm toes of good color in all positions with a positive histamine test, etc.

Amputation is done when conservative methods fail to stop unbearable pain, fail to heal the ulcer or small area of gangrene, or fail to control slight infection or frank suppuration. It is done when economic exhaustion forces a rapid conclusion of the case. It is done when there is gangrene which includes the whole of one or more toes or more of the foot or leg tissue, or if the gangrene area is small but progressive and non-demarcated, or if there is deep or ascending infection which threatens the patient's life.

Amputation of one or more toes will suffice for the minimal lesions under the conditions described as suitable for conservative management, if conservative management fails. It will suffice in gangrene limited to the toe or in osteomyelitis of a phalanx without gangrene if the dorsalis pedis or posterior tibial pulses are palpable. Or if either is not palpable, evidence of good collateral circulation must be present in the form of freedom from severe pain, a warm foot of good color in all positions with a moderate oscillometric excursion or a good histamine test and a well demarcated lesion.

If these conditions are not fulfilled, a midleg or higher amputation must be done. Midleg amputations will suffice if there is good pulsation in the popliteal artery or if there is good oscillometric excursion at midleg level, if the skin is of good color in all positions and shows no temperature change level down to the ankle and if the salt solution or histamine tests are positive down to ankle level. It will be seen that a greater margin of collateral safety is required in arteriosclerotics than in Buerger's disease. There must be no rapidly spreading infection and no lymphangitis above the lower third of the leg. The patient should be in good general condition and less than 55 or 60 years of age. In a patient who is blind or who is in such mental or general condition that it is probable he will never walk again, it is safer to do a thigh amputation rather than take chances with a lower amputation in order to save leg length which the patient will never use. It is especially urgent that a midleg rather than a thigh amputation be done when possible if the condition of the other foot is such that subsequent trouble in the latter seems probable.

The best leg length obtainable is 6 to 9 inches below the tibial tubercle. 4 to 6 inches is usually good enough. The fibula is to be cut 1 inch higher unless infection below makes extra operative manipulation inadvisable. The level selected may be raised accordingly as the above conditions are not fulfilled to within an inch or two of the tibial tubercle. In these cases, it is advisable to expose the entire head of the fibula except under circumstances as stated above (Speed).

Above this level, the Gritti-Stokes operation is recommended, but is open to the same objections which were described under Buerger's disease. The operation is more complicated, blood supply to the flaps is not so good and healing is irregular. Further, the chief reason for which it is chosen, namely, to provide a laborer who has to stand on his feet all day with an end bearing stump is rarely called for in patients of this age group and general condition. The fact that it is a closed operation automatically excludes it from any case in which amputation is done for infection. If a Gritti-Stokes operation is possible, the mechanical advantage of a supracondylar amputation is just as good and healing is surer.

The elective thigh amputation is done about 3 inches above the knee. It is done when popliteal pulsation is absent, and the skin is not warm and of good color in all positions down to the level of the ankle, when oscillometric excursion in the leg is absent, but is present in the lower thigh or is substituted there by a good histamine or salt solution test, and when the temperature change level is below the knee. It is done if the patient is over 60 years of age or in poor general condition, and in extensive or rapidly spreading infection.

If femoral pulsation is not obtained, if oscillometric excursion in the lower third is weak or absent, if this portion is cold and the histamine test is weak or negative here, or infection has spread to the knee or general sepsis is more severe, a midthigh amputation is done.

It is folly to close an amputation done for sepsis; infection does not stop at the level of skin redness. Far above the hyperemic zone lymphatics and veins are saturated with organisms and closure of the wound invites disaster. At least half of the postoperative mortality is due to sepsis. Open amputation will not only reduce mortality but will increase length of limb safe to leave.

After recovery a temporary prosthesis should be fitted as soon as the stump condition permits. Active exercise will even improve the healing power of the stump. This prosthesis is used for 3 to 6 months until the stump has shrunk to its definitive size and an artificial limb can be fitted.

DIABETES

The problem of gangrene in the diabetic cannot be dismissed along with arteriosclerotic gangrene, because only a portion of the diabetic gangrenes are arteriosclerotic. The diabetic is threatened with gangrene from three fronts: arteriosclerotic, infectious and embolic or thrombotic (42, 43).

Arteriosclerotic gangrene in the diabetic is essentially similar to arteriosclerotic gangrene in the non-diabetic, and is handled in much the same way. It occurs in the old age group. The diabetes itself is probably due to arteriosclerosis in the pancreas and is usually mild and fairly easily controlled. It does not itself court serious sepsis and the gangrene problem remains predominantly that of circulatory deficiency.

The only difference is that once the diabetes is started it hastens the arteriosclerosis (23, 36). This it does perhaps by virtue of the lipæmia associated with the abnormal metabolism and high fat diets of the disease. We know that as the diabetic factor becomes more prominent, intimal changes in the muscular arteries become more and more prominent in comparison with medial changes. Fat deposition in the internal elastica becomes more and more predominant and medial sclerosis falls behind in the sclerotic picture. The whole process is accelerated and gangrene occurs in the diabetic arteriosclerotic some 10 years earlier than in the non-diabetic arteriosclerotic.

The diabetes itself, though mild must be reckoned with, and proper dietary and insulin management instituted. A high carbohydrate diet with insulin is preferable to the high fat diet without insulin because the lipæmia of the latter encourages intimal atheromatosis and it is this factor which not only hastens the vascular occlusion but paralyzes the development of collaterals. At a given age it is the patient with most medial sclerosis and least intimal changes who has the best collateral development. The diabetes also though mild, does introduce an added bacterial danger, so that infections must be prevented or treated even more assiduously than in the non-diabetic. The other diabetic hazards of hyperglycæmia or hypoglycæmia, acidosis and malnutrition must be avoided (5, 33).

In this group of aged diabetic arteriosclerotics little can be expected from collateral circulation, in most cases. Yet, as in the non-diabetic cases if the occlusive process is slow enough, considerable collateral development may occasionally occur and permit amputation at a lower level. With the infectious element evaluated, the selection of amputation levels is based on the same criteria as in the non-diabetic arteriosclerotic.

Arteriosclerosis, particularly the intimal type, begins even in young diabetics provided they have had the diabetes for 5 years or longer. Gangrene occurs in young diabetics, but the chief rôle in the gangrene of young diabetics is played by infection rather than by arteriosclerosis.

In proportion to the severity of the diabetes the general and local resistance to infection is decreased. Dry gangrenes quickly become infected, superficial infections develop quickly, even gas bacillus infections are particularly prone to develop in diabetics, and the tendency to general septicæmia is marked. The tissues are very sensitive to pressure, heat, or strong antiseptics. This may be due to increased sugar in the tissues, to hyperglycæmia, to ketosis, to the secondary intimal sclerosis, etc. Whatever the cause, the threat of infection in the diabetic is formidable.

When gangrene develops in a diabetic, the younger the patient, the more likely it is that the gangrene is on an infectious basis rather than on an arteriosclerotic. Usually the younger the patient with gangrene, the worse is the diabetes. The worse the diabetes, the greater is the diabetic intimal sclerosis and the greater the inhibition of collateral development. But this is far outweighed by the greater collateral potential of the younger patient, and circulatory embarrassment therefore plays a lesser rôle. On the other hand, though cellular virility is greater in the younger patient, the increased severity of his diabetes more than balances this, and infection is likely to run rampant.

In any case of gangrene in a diabetic, the rôle of the infectious element and the rôle of the circulatory element must be separated and evaluated. The first step in this process as in all types of gangrene is an estimation of the circulatory status of the limb. If the patient is young, the diabetes relatively recent, a history of claudication absent, pain slight and in proportion to the amount of infection, pulsation or good oscillometric excursion present, or if absent, the foot is warm without temperature change level and is of good color in all positions, shows a positive salt solution or histamine test and if infection or gangrene is well localized, the presence of good circulation is established and the case can be handled as a simple infection or as a severe infectious or traumatic gangrene (65). In proportion as these conditions are not fulfilled, circulatory deficiency must be added to the gangrene picture and included in the prognostic and therapeutic decision.

The infections, foot infections, small ulcers, and small areas of gangrene should be treated conservatively provided there is adequate direct or

collateral vascular supply. Accurate diabetic management, free incision and drainage, and treatment of the lesion along general surgical principles will take care of the situation. Slight circulatory deficiency can be corrected by the measures instituted under the minimal lesions described in arteriosclerotic gangrene (29).

If good circulation is established, toe amputation may be done for osteomyelitis of a phalanx or to improve drainage of infection in the deep fascial planes of the foot, or for ulcers or small areas of gangrene which remain unhealed after prolonged conservative management. The wound should be left open in all amputations done for infection. In all cases in which the *dorsalis pedis* did not pulsate, and in all cases of infectious gangrene with or without *dorsalis pedis* pulsation. Only in direct traumatic gangrenes without infection or in osteomyelitis which is well localized and carries no doubt of circulatory sufficiency can the wound be closed loosely.

Major amputation must be done if the diabetes can no longer be controlled by diet and insulin. If there are signs of a rapidly spreading infection or gangrene or if there is a local uncontrollable violent infection with signs of septicemia or severe toxemia. In these diabetes, the indication for amputation is primarily infectious, but the severity of the infection depends partly on the circulatory status and the level of amputation chosen depends on both.

It is these situations in particular which call for the most careful choice of amputation level. Re-amputations are at least five times as dangerous in diabetes as in simple arteriosclerotics. Re-amputations add 15 (Eliason) to 35 per cent (McMahon) to the operative mortality in diabetic gangrene. A gangrenous diabetic extremity must be amputated only once and that at a level which will furnish sufficient blood supply and insure control of the infection. No temporizing is permitted. The patient is prepared as for potential diabetic coma, and decisive amputation done at once (24, 50, 59).

On the other hand, it is just this group of young diabetics with good circulation who suffer needlessly high amputations and are left needlessly crippled because the gangrene they present is treated in the same way as the senile arteriosclerotic type. It is not necessary to go always above the knee. In this group with a good direct or collateral vascular supply the amputation can be done on the infectious indication only and thereby limb length saved.

Midleg amputation can be done in patients under 45 or 50 (reckoning that arteriosclerosis is

hastened by 10 years in diabetes) if the patient is in good general condition if the infection is restricted to below the ankle and adequate circulation established. By adequate circulation is meant popliteal pulsation or good oscillometric excursion in the middle third of the leg with good temperature and color down to the level of the ankle, and a positive histamine reaction as low at least as the amputation level. With the same degree of infection, the poorer the circulatory status, the higher the amputation must be.

The Grift-Stokes is not recommended because this situation in particular does not admit prolonged operative maneuver. Longer and better healing stumps will be left with less complex operations (Mates, 39).

Amputation is done above the knee in patients over 45 or 50 or who are in poor condition or when gangrene involves the entire foot, when infection spreads above the lower third of the leg or even with less severe infection when circulation cannot be established below the knee. For all these amputations for infection, the open operation will permit greater stump length will insure better control of infection and eventual healing.

The third type of gangrene in the diabetic, that due to an embolic or thrombotic accident, depends entirely upon the previous circulatory and infectious condition of the limb. Prognosis and treatment depend on these latter factors in addition to the size of the embolus or the thrombus and the development of secondary thrombosis. The diabetes itself is only a complication which makes circulatory deficiency more likely and secondary infection more virulent. Except with very small emboli or thrombi, collaterals have no time to develop. Young patients with good previous circulation can weather a much more severe acute occlusion than older patients with previous circulatory damage. Embolectomy could then be done were the patient seen early enough or could even be done later to improve circulation after the original onslaught had subsided. Mycotic emboli are more poorly borne than the bland. In older individuals with poorer previous circulation or with larger emboli or rapid secondary thrombosis, the prognosis is bad. Amputation must eventually be done at the level of circulatory insufficiency determined by the tests described.

SUMMARY AND CONCLUSIONS

An attempt has been made to analyze the amputation criteria involved in cases of circulatory disturbances of the lower extremities on the basis of the pathogenesis of the underlying conditions.

The primary element in the amputation decision is an estimate of the circulatory status of the limb. The importance of pre-operative and post-operative management to encourage collateral development is emphasized.

Amputation need not always be done at or above the knee in Buerger's disease. It is done at the lowest level compatible with the assurance of healing given by the circulatory tests.

In arteriosclerosis also careful circulatory study can save limb length. Not all diabetic gangrenes are to be handled alike. One group is essentially arteriosclerotic, the other group is essentially infectious. Diabetes is common to both only as a complication and the proper amputation levels are widely different.

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TORSION OF THE FIBROMATOUS UTERUS¹

A SURGICAL EMERGENCY

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TORSION of an abdominal viscus or tumor, with the consequent interference with the blood supply, constitutes a serious surgical emergency. Torsion of any of the abdominal organs (except the liver) may occur, and twists of a pedunculated tumor, usually an ovarian cyst or fibroid are relatively common. Rotation of a fibroid uterus, on the other hand is but rarely encountered, as might be expected when one considers the stability of the normal organ, supported as it is by the broad and the round ligaments which, while permitting fairly free movement in an anterior and a posterior direction, furnish considerable resistance to any lateral torsion. When, however, the uterus is enlarged, and rising out of the pelvis becomes an abdominal viscus the cervical segment is elongated, the ligaments are stretched, and the chance of a torsion becomes greater. Cases of torsion of a pregnant uterus have been reported, but while they have a number of points in common with torsion of a fibroid uterus they will not be considered in this paper; the reader is referred to articles by Robinson and by Feiner and Kaldor, the latter of whom were able to collect 11 such cases. Tumors of the adnexa may also cause torsion of the uterus but these again are not discussed in this report; readers are referred to Girod, who, in reporting 87 cases of torsion of the uterus produced by tumors considered that the rotation was produced by tumors of the adnexa in 33 cases² and by fibroids in 54.

In looking through the literature we have been able to collect only 8 cases of torsion of a fibroid uterus reported from the United States; many more cases, however, have been reported from other countries and a fairly extensive European literature on the subject exists. A brief review of this material will be given later in this paper. The following case is reported because it represents an interesting and somewhat rare, example of emergency surgery for acute abdominal pathology.

Case No. 9137, Mary Imogene Bassett Hospital. On August 13, 1935, E.B., a 62 year old married housewife, a native of New York State, was admitted to the hospital.

¹These are listed as follows: 1) at left ovary, 15) at right ovary, 6) at ovary side not designated, 6) tumor at ovary, 3) and perovarian cyst, 3.

She complained of abdominal pain of 4 days' duration and abdominal tumor of 2 years' duration. The family history was not important. The more pertinent points only of the past history are presented.

Patient has been married for about 43 years; there were 5 full term pregnancies, 42 and 20 years ago respectively. The first delivery was instrumental and she suffered severe lacerations of the perineum. For a number of years the patient has been troubled by frequency of urination and burning. Meneses began at the age of 12 and were always essentially normal; menopause occurred 18 years ago. She has suffered considerably from leucorrhoea for the past few years; the discharge, which was previously whitish in color has become dark brown.

The patient has had no recent neurological symptoms, except that at times she has been troubled by numbness and tingling of her fingers. In 1907, 26 years ago, she had a perineal repair and suspension of the uterus. About 5 or 6 months ago on two occasions within a period of a few days, there was a small amount of vaginal bleeding amounting to a few teaspoonfuls of blood on each occasion. Two years ago the patient noticed a "small tumor" in the lower left part of the abdomen, since that time the abdomen has increased in size. For the first year there were practically no symptoms, about a year ago she noticed a heavy dragging sensation in the lower abdomen, with some backache at times she has had attacks of acute lower abdominal pain. During the past 3 months her abdomen has rapidly increased in size, she has felt increasing weakness, and has begun to suffer from shortness of breath, palpitation of the heart, and frequent gaseous eructations from the stomach. She has lost a good deal of weight, her best weight having been 200 pounds, her weight on admission 170 pounds. In spite of her symptoms, however she has been able to carry on an active life and to do her own housework.

Four days before admission the patient noticed a dull, aching sensation in her lower abdomen and left thigh, and a few hours later she was taken with pains, sharp and knife-like in character, across her lower abdomen, particularly on the left side. The pain persisted throughout the following day and her abdomen became exquisitely tender; she had considerable dyspnoea and felt dizzy and faint. For the past 2 days she has been under the care of her physician who has given her a considerable amount of morphine because of the severity of her pain. She has vomited on a number of occasions and has felt nauseated most of the time. Any movements, such as turning over in bed, have greatly increased the abdominal pain, especially when she has been lying on her right side. The bowels have moved several times since the onset of the attack of pain; the patient has had urinary frequency which she has suffered from for a number of years.

Physical examination revealed the following: Patient was an elderly woman with marked pallor of skin and mucous membranes, there was some cyanosis of her nail beds. She appeared to be acutely ill; respirations were somewhat rapid and grunting; pulse rapid, thready and barely palpable. She lay on her left side and cried out in pain if any attempt was made to move her; she belched gas frequently.

Examination of the head was negative. Heart and lungs were essentially negative except for tachycardia. The abdomen was markedly distended by a tumor mass as large as a full term pregnant uterus, and apparently slightly more prominent on the left than on the right side. Dullness was present over the abdomen, except in the right flank and epigastrium, where there were areas of tympany. No fluid wave was noted. The tumor mass was apparently smooth, no nodules were made out. Marked tenderness, even on light pressure, was noted over the whole abdomen. Pelvic examination was not very satisfactory; the cervix was small and high in the vagina, no tumor mass filled the pelvis, the body of uterus could not be identified.

On admission the patient's temperature was 102 degrees, pulse 130, respirations 21.

Pre-operative laboratory findings. Red blood cells, 2,400,000; white blood cells, 17,500; hemoglobin, 45 per cent; polymorphonuclears, 83 per cent; eosinophiles, 1; basophiles, 0; large lymphocytes, 2; small lymphocytes, 8; mononuclears; platelets diminished; moderate anisocytosis, polychromatosis and achromia, non-protein nitrogen, 31 milligrams. Urine clear amber specific gravity 1.022 reactions, and albumin, heavy trace acetone negative, sugar negative occasional white blood cell, rare red blood cell.

Treatment. The exact pathology responsible for the acute attack was not clear in spite of the indications of a strangulated tumor; the fact that the patient had been losing weight and strength for a year with marked anemia, raised the question of abdominal neoplasm with some added complication. An exploratory operation seemed to offer the only help, but it was felt that unless her condition could be somewhat improved she would not survive even the simplest operative procedures.

On the night of admission the patient was given an intravenous infusion of 1000 cubic centimeters of 10 per cent glucose which brought some slight improvement. On the next day, however, her condition was extremely critical, the pulse was barely palpable at the wrist and she was mentally stuporous and confused. Following transfusion of 500 cubic centimeters of whole blood, her condition was somewhat improved; a small stomach tube was passed and a considerable amount of gas and small amount of fluid drawn off, giving her much relief. She was given another intravenous infusion of 500 cubic centimeters of 10 per cent glucose. On the following morning her condition seemed to be definitely better and it was felt that we could proceed with an exploratory operation under novocain as the anesthetic.

Operation. Under novocain anesthesia a small exploratory incision was made at about the middle of the abdomen through the left rectus muscle. The tumor that presented in the wound after incising the peritoneum did not appear to be malignant; it was smooth, non-adherent, soft, and elastic on palpation. Since the patient's condition was so precarious it seemed desirable, if possible, to aspirate the enormous tumor to facilitate its delivery; a hollow needle was accordingly introduced, but the tumor was found to be solid. The incision was then greatly enlarged, both upward and downward, following which it was possible to deliver the whole tumor. The picture presented was striking; the main mass of the tumor consisted of a large fibroid uterus which had undergone rotation, apparently making a complete turn of 360 degrees, clockwise, at the cervical segment, the broad ligaments, tubes, and ovaries were black and gangrenous in appearance, the broad ligaments distended with extravasated dark colored blood clots.

After the tumor was reduced, a supravaginal hysterectomy was carried out. The uterine arteries and ends of the broad ligaments were transfused and ligated, and the uterus amputated. The cervical stump was closed over

with interrupted silk sutures; the abdominal wound was then closed in layers. Silk sutures were used throughout the operation. The patient's general condition improved definitely as soon as the abdominal tumor had been delivered.

Postoperative progress. The patient's condition on the day after the operation was satisfactory; temperature 100.3 degrees, pulse 93. She had considerable gaseous distention (as was to be expected, since the intestines were considerably distended at the time of operation) which yielded to simple measures; the stomach was kept empty by means of a small stomach tube passed through the nares, liberal doses of morphine were given, and flamed pessaries and rectal tubes employed. The patient was given intravenous infusions of glucose and saline.

For the first few days the patient was mentally "flighty," a little confused at times, talking somewhat irrationally. Her convalescence on the whole, however, was smooth and satisfactory. The abdominal wound healed by first intention. For some time she ran slight evening elevation of temperature (about 100 degrees rectal) for which on adequate explanation was ever found; possibly it was related to some chronic infection of her urinary tract, or there may have been some phlebitis of the pelvic veins. Her anemia improved markedly after the administration of iron and liver extract. The patient was discharged in excellent condition on October 5.

Pathological report. The report of the gross examination of the specimen removed at operation is as follows:

"Specimen consists of a large tumor weighing 13½ pounds and measuring 24 by 21 by 21 centimeters (see Fig. 1). The surface is smooth and dark-purplish red in color, marked by dilated superficial veins. At several points it is discolored and dark bluish-black, apparently from superficial subcutaneous necrosis. Attached to either side near the pedicle are very large broad ligaments filled with blood, on neither side can the ovary be positively identified. The raw area where the tumor was removed from the body measures approximately 3 by 6 centimeters and is roughly oval in shape.

"On section, the upper four fifths of the tumor is composed of firm tissue arranged in irregular masses varying in size from 2 to 1 centimeters in diameter (see Fig. 2). These islands of tissue have a fibrous-like structure for the most part and they stand up above the intervening interstices. Toward the cervical end of the mass the tissue is of different structure, suggesting normal uterine muscle extensively infiltrated with blood."

Microscopic examination showed the typical picture of fibromyoma of the uterus.

HISTORICAL SURVEY

Although Times (1867) is considered the first to have reported an observation of axial rotation of the uterus, the exact pathological condition in his case is not clear from the data presented.

In 1863 a case of torsion of a myomatous uterus was described by Virchow. In this instance the twist was found at autopsy in a 63 year old woman who had died of pneumonia.

Following Virchow's case many others were reported, especially in the German literature. Outstanding studies have been made by Schultze, in articles appearing in 1898 and 1906 by Girod, who gave a complete résumé in 1903 of 54 cases (including those reported by Schultze) by

Piquand and Lemeland who in 1909 discussed not only cases of torsion of the fibromatous uterus itself but also twists of pedunculated fibroids by Hitzamides, who added 8 new cases to the collection in 1926 and by Peigthal who in 1929, collected 47 cases that had appeared in the literature since Hitzamides' article and added 1 of his own. Peigthal considered that although it was impossible to give exact figures, since different authors included different types of cases¹ at least 133 cases had been reported up to that time. Since Peigthal's article in 1929 6 have been reported in the literature and are here briefly summarized.

SUMMARY OF CASES REPORTED SINCE 1929

1. Reported by Cotte. Patient, a married woman of 38 years, was waken from sleep 24 hours before admission by an acute attack of abdominal pain, no nausea or vomiting. A tender abdominal mass was palpable.

Operation revealed multiple myomata, the uterus was twisted from left to right 180 degrees. Myomectomy was done and the uterus returned to position, result cure.

2. Reported by Santy. Patient, a married woman of 47 years, suffered an acute attack of pain 30 days before admission, she had had a similar attack, lasting a few hours, a year before. Apparently she had a large hypogastric tumor.

Operation revealed a purple, gangrenous tumor adherent to the fundus of the uterus, which was also gangrenous and was twisted on the isthmus. Subtotal hysterectomy was done resulting in cure.

3. Reported by Courty (6). Patient, a woman of 63 years, was seized 14 hours before admission by sudden severe attack of pain and shock with vomiting, she was in extremis when admitted. A tender abdominal mass, the size of a head, could be felt. Patient was known to have had an abdominal tumor 30 years before admission, with minor abdominal crises since then.

Operation revealed a pelvis full of serohemorrhagic fluid, large tumor on the fundus. Direction of twist was not indicated, weight 3,800 grams. Pneumonia set in on the sixth day after operation and patient died.

(Courty also discusses 3 cases, one simulating intestinal obstruction and the other characterized by repeated minor attacks, reported by other men.)

4. Reported by Courty (7). Patient, a married woman of 45 years, was taken with violent abdominal pain, nausea, and vomiting. Examination showed a large abdominal tumor apparently of the uterus.

Operation revealed a left to right torsion of uterus at the isthmus. Fibroid occupied the whole body of uterus and was red violet in color. Subtotal hysterectomy was done and patient recovered.

5. Reported by Werneck. Patient, an unmarried woman of 35 years, entered the hospital with a hard, painful tumor. The pain radiated from the lower abdomen to the sacral region of the back, and had been increasing in severity. The menstrual periods had been normal until 12 months ago, when they became irregular; the last period was a month before admission.

Examination revealed that the abdomen was distended by a hard nodular tumor extending above the umbilicus.

The hymen was intact. Rectal examination was painful, the tumor seemed slightly movable. A diagnosis of uterine myoma was made.

At operation a tumor arising in the pelvis was found, its upper border attached to the ileocecal junction portion of the intestine. After freeing the adhesions, the tumor was delivered; it was found to be a fibroid uterus, twisted at the isthmus from left to right; the ovaries were located lying close to the pedicle of the twist. Subtotal hysterectomy and bilateral salpingectomy were carried out.

The tumor was dark red in appearance, and about the size of a 6 months' pregnancy. There were numerous fibroid nodules over the surface. Longitudinal section showed necrosis of the entire tumor and uterus, due to the twist at the isthmus of the uterus.

Convalescence was uneventful.

6. Reported by Battaglini. Patient was a woman of 39 years, who had been married for 16 years; she had never been pregnant. After amenorrhea of 50 days duration she had a sudden pain in the left side of the abdomen and a bloody vaginal discharge which lasted for a week. After the patient had recovered from the acute attack she was seen by Dr. Battaglini, who found a hard, painful swelling about the size of the head of a full term fetus, in the left lower quadrant of the abdomen. Pelvic examination showed the same mass. Diagnosis: fibroma with twisted pedicle.

Operation revealed an extrapelvic tumor with omental adhesions, attached to the left cornu of the uterus by a pedicle which was twisted from right to left through 370 degrees; the body of the uterus had undergone similar torsion. The adhesions were severed and a hysterectomy carried out.

SUMMARY OF CASES REPORTED IN THE UNITED STATES

Eight cases were found in the literature as noted before, and are summarized below. The first case was reported by Homans in 1892.

1. Reported by Homans. Patient, an unmarried woman of 58 years, suffered a sudden attack of severe pain with vomiting. She was known to have had fibroid tumor of uterus for 16 years. On examination, the abdomen was found to be very tender; a hard, round tumor extended above the umbilicus.

Operation was advised but refused; patient died on thirty-ninth day of illness.

Autopsy showed fibropurulent peritonitis. Lower abdomen was filled with smooth, rounded growth extending above umbilicus and covered with adherent omentum. The tumor was dark outside, purple inside; to it was attached a smaller mass, apparently body of uterus. The twist was very tight, resembling a rope and in it were contained, in addition to the flattened body of the uterus, both broad ligaments with their contents. Both ovaries were more or less cut off from their blood supply. The torsion was from left to right, "one and a half times" weight of tumor about 6 pounds.

2. Reported by Goffe. Patient was a single woman 45 years of age, who had been treated for the past 18 months for "intestinal indigestion."

Operation performed was a supravaginal hysterectomy; patient recovered.

Specimen removed at operation showed an interstitial fibroid, arising from the posterior wall of the uterus, twisted from left to right through 180 degrees; the entire tumor, with attached cyst, reached upward to the liver.

¹ Some authors, for example, include torsion of the uterus during pregnancy and some do not.

Examination of the head was negative. Heart and lungs were essentially negative except for tachycardia. The abdomen was markedly distended by a tumor mass as large as a full term pregnant uterus, and apparently slightly more prominent on the left than on the right side. Dullness was present over the abdomen, except in the right flank and epigastrium, where there were areas of tympany. No fluid waves were noted. The tumor mass was apparently smooth, no nodules were made out. Marked tenderness, even on light pressure, was noted over the whole abdomen. Pelvic examination was not very satisfactory: the cervix was small and high in the vagina. No tumor mass filled the pelvis, the body of uterus could not be identified.

On admission the patient's temperature was 101 degrees, pulse 130, respirations 24.

Pre-operative laboratory findings. Red blood cells, 2,400,000, white blood cells, 21,500, hemoglobin, 45 per cent; polymorphonuclears, 58 per cent, eosinophiles, 1, basophiles, 0, large lymphocytes, 2, small lymphocytes, 8, mononuclear platelets diminished, moderate anisocytosis, poikilocytosis and schistocytes. Non-protein nitrogen, 31 milligrams. Urine clear amber specific gravity 1.022 reaction, acid albumin, heavy trace acetone negative, sugar negative occasional white blood cell rare red blood cell.

Treatment. The exact pathology responsible for the acute attack was not clear in spite of the indications of a strangulated tumor: the fact that the patient had been losing weight and strength for a year with marked anemia, raised the question of abdominal atherosclerosis with some added complication. An exploratory operation seemed to offer the only help, but it was felt that unless her condition could be somewhat improved she would not survive even the simplest operative procedures.

On the night of admission the patient was given an intravenous infusion of 1000 cubic centimeters of 10 per cent glucose, which brought some slight improvement. On the next day however her condition was extremely critical, the pulse was barely palpable at the wrist and she was mentally stuporous and confused. Following transfusion of 500 cubic centimeters of whole blood, her condition was somewhat improved, a small stomach tube was passed and a considerable amount of gas and small amount of fluid drawn off giving her much relief. She was given another intra-venous infusion of 50 per cent glucose. On the following morning her condition seemed to be definitely better and it was felt that we could proceed with an exploratory operation under novocain as the anesthetic.

Operation. Under novocain anesthesia a small exploratory incision was made at about the middle of the abdomen through the left rectus muscle. The tumor that presented in the wound after incising the peritoneum did not appear to be malignant: it was smooth, non-adherent, soft, and elastic on palpation. Since the patient's condition was so precarious it seemed desirable, if possible, to separate the enormous tumor to facilitate its delivery. A hollow needle was accordingly introduced, but the tumor was found to be solid. The incision was then greatly enlarged, both upward and downward, following which it was possible to deliver the whole tumor. The picture presented was striking: the main mass of the tumor consisted of a large fibroid uterus which had undergone rotation, apparently making a complete turn of 360 degrees, clockwise, of the cervical segment, the broad ligaments, tubes, and ovaries were black and gangrenous in appearance, the broad ligaments distended with extravasated dark colored blood clots.

After the tumor was reduced, a supravaginal hysterectomy was carried out. The uterine arteries and vessels of the broad ligaments were transfected and ligated, and the uterus amputated. The cervical stump was closed over

with interrupted silk sutures the abdominal wound was then closed in layers. Silk sutures were used throughout the operation. The patient's general condition improved definitely as soon as the abdominal tumor had been delivered.

Postoperative progress. The patient's condition on the day after the operation was satisfactory: temperature 100.2 degrees, pulse 98. She had considerable gastric distention (as was to be expected, since the intestines were considerably distended at the time of operation) which yielded to simple measures: the stomach was kept empty by means of a small stomach tube passed through the nares, liberal doses of morphine were given, and flaxseed poultices and rectal tubes employed. The patient was given intra-venous infusions of glucose and saline.

For the first few days the patient was mentally "slightly" a little confused at times, talking somewhat irrationally. Her consciousness on the whole, however, was smooth and satisfactory. The abdominal wound healed by first intention. For some time she ran slight evening elevation of temperature (about 100 degrees rectal) for which no adequate explanation was ever found; possibly it was related to some chronic infection of her urinary tract, or there may have been some phlebitis of the pelvic veins. Her anemia improved markedly after the administration of iron and liver extract. The patient was discharged in excellent condition on October 5.

Pathological report. The report of the gross examination of the specimen removed at operation is as follows:

"Specimen consists of a large tumor weighing 1355 pounds and measuring 24 by 21 by 21 centimeters (see Fig. 1). The surface is smooth and dark-purplish red in color marked by dilated superficial veins. At several points it is discolored and dark bluish-black, apparently from superficial subserosal necrosis. Attached to either side near the pedicle are very large broad ligaments filled with blood on neither side can the ovary be positively identified. The raw area where the tumor was removed from the body measures approximately 3 by 6 centimeters and is roughly oval in shape.

"On section, the upper four-fifths of the tumor is composed of firm tissue arranged in irregular masses, varying in size from 1 to 10 centimeters in diameter (see Fig. 2). These islands of tissue have a fibrous like structure for the most part and they stand up above the intervening interstices. Toward the cervical end of the mass the tissue is of different structure suggesting normal uterine muscle extensively infiltrated with blood.

Microscopic examination showed the typical picture of fibromyoma of the uterus.

HISTORICAL SURVEY

Although Times (1861) is considered the first to have reported an observation of axial rotation of the uterus, the exact pathological condition in his case is not clear from the data presented.

In 1863 a case of torsion of a myomatous uterus was described by Virchow. In this instance the twist was found at autopsy in a 63 year old woman who had died of pneumonia.

Following Virchow's case many others were reported, especially in the German literature. Outstanding studies have been made by Schultz in articles appearing in 1898 and 1906 by Giroud, who gave a complete résumé in 1903 of 54 cases (including those reported by Schultz) by

venous return is the first to suffer. Hemorrhagic infiltration under the peritoneal coat may give a dark red or violet purple appearance to the tumor (20). Bloody fluid may be found in the peritoneal cavity (8).

In the case reported in this paper in spite of the severe twist and the long duration, the main body of the tumor showed surprisingly little evidence of disturbance to its circulation, the principal damage occurring in the broad ligaments tubes and ovaries, which were heavily infiltrated with dark colored coagulated blood. As will be noted from Figure 2 the hemorrhage also extended upward from the broad ligaments under the peritoneal coat of the uterus. The ovarian tissue had degenerated so that it could not be identified in the histological sections taken from the region of the ovary. Gordon Watson and Shaw record that in their case also the fallopian tubes and ovaries were deeply congested and showed early necrotic changes. The extent to which the adnexa may suffer in the more severe torsions of the uterus is clearly illustrated in the accompanying cuts (Figs. 1 and 2).

Polak and Mazzola have studied experimentally the effects of torsion of the uterus on the vessels of the parametrium and contiguous tissues, and found that displacement of the uterus caused an increase in the size of the organ and in the size and number of the vessels. Presumably these experimental torsions are comparable only to the chronic clinical types discussed later.

The bladder (according to Peigntal) at times shows compression and edema of its walls. An intestinal loop may become involved in the rotation resulting in intestinal obstruction (6, 14). The intestines may also show considerable gaseous distention (as occurred in the case here reported) due to functional disturbances of motility. If the torsion persists for any appreciable length of time before being reduced adhesions to all surrounding structures may take place (20).

The torsion. The torsion usually takes place at the isthmus of the uterus. As a rule this structure is gradually thinned and stretched as the tumor increases in size; rarely the whole uterus is elongated and involved in the twist (12). The direction of the twist is usually from left to right, that is, clockwise (15, 16). Instances have been reported, however, in which the twist was counterclockwise (9). The degree of rotation is usually 180 degrees, although it may be only 90 degrees. Among Girod's cases, of the 57 where the degree of rotation is stated 58 per cent were twisted 180 degrees, 7 cases were reported as

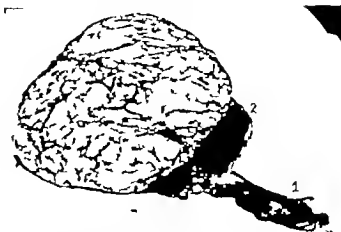


Fig. 2. A longitudinal section through the tumor mass. 1 indicates the right broad ligament, tube and ovary. 2 an old blood clot extending upward underneath the peritoneal covering of the uterus.

360 degrees (which is the degree of torsion in the case here reported) a twist of 450 degrees has been recorded by Gordon-Watson and Shaw.

ETIOLOGY

There has been considerable speculation as to the cause of torsion of the uterus. The condition is usually found in women over 40 years old (which of course fits in with the prevalence of large fibroids among this age group) and occurs most often in old women (30). An occasional instance has been reported in young women. Mundé (18) reports a case in a girl of 19. In this case the tumor responsible for the torsion was said to be about the size of a 6 months pregnant uterus.

Usually before a rotation occurs the growth of the tumor has produced a thinning and stretching out of the isthmus, so that when eventually the uterus becomes an abdominal organ the isthmus constitutes a pedicle and the immediate mechanism of torsion is that of torsion of any pedunculated tumor as for example an ovarian cyst. It is probable that movements of the body (such as bending down, turning over in bed, etc.) are important in initiating the twist. Asymmetry in the growth of the tumor may be an additional factor; the filling and emptying of the bladder and sigmoid have been suggested (20, 30) but it is difficult to see how this movement could exert a force sufficient to twist a large, heavy tumor.

Difficult as it is to explain the occurrence of one twist, it is even harder to say why multiple twists take place. In the case here reported in which the rotation was through a circle of 360 degrees the patient had had attacks of abdominal



FIG. 3. Twists of the fibromatous uterus: specimens from various authors. A, Bland Sutton's specimen: a subserous fibroid which had undergone axial rotation and involved the uterus in the twist. "tumor the size of the head of a newborn infant." In this case the symptoms were mild. B, Rocura's specimen: atrophic uterus with large fibroid, 20 by 10 by 8 centimeters, rotation of 90 degrees found at operation. C, Peigthal's specimen: weight 2.6 kilograms; acute fibroid, developed from top of fundus. C, amputated cervix; F, fibroid, L, round ligament, T, tubes, O, ovaries.

pain in the past, and it is possible that the first twist of the tumor took place a number of weeks before admission to the hospital, another occurring at the onset of the attack which brought her into the hospital.

The question as to why the rotation occurs to the right more frequently than to the left has also been a subject of considerable speculation but no adequate explanation has been offered. It has been suggested (15) that since a pregnant uterus becomes somewhat dextrorotated as it increases in size the same change may occur in the growing tumor.

CLINICAL PICTURE

The cases fall into two clinical groups: one giving an acute, fulminating picture similar to that encountered in twists of an ovarian cyst or pedunculated fibroid, the second presenting mild symptoms which sometimes continue over a period of years.

In the group of acute cases the attack is apt to come on suddenly with excruciating pain, and is often accompanied by nausea, vomiting and varying degrees of collapse. Physical examination discloses an abdominal tumor, tenderness and muscle spasm; the tumor may be nodular suggesting a fibroid rather than an ovarian cyst. Vaginal examination may or may not be helpful, depending somewhat on the size and location of the tumor. In the case here reported, no mass could be palpated in the pelvis, because the tumor was entirely abdominal; the cervix could

be palpated high in the vagina as is frequently noted in these cases. There is ordinarily some elevation of the temperature and pulse rate and a leucocytosis is usually present. This syndrome usually points to a strangulation of a tumor; and because of the frequency of twisted ovarian cyst, that is often the diagnosis made.

The second clinical syndrome is that of the chronic or subacute case in which the twist is not sufficient to produce extensive vascular changes causing severe symptoms. There may be a history of attacks of low abdominal pain over a period of several years, and of irregular menses, discomfort and frequency of micturition were important symptoms in a case of the chronic type reported by Bland Sutton. In this group of cases it has been stated that the fact that a uterine sound or catheter cannot be passed into the uterine cavity is an important diagnostic point. The subacute or chronic symptoms may be followed by an acute attack which may, as suggested in this case report, be occasioned by a second twist.

TREATMENT

In all cases of the acute group and probably in most of the chronic variety laparotomy is indicated. As has already been pointed out, the severity of the symptoms in the acute group indicates interference with the circulation and it is desirable that operation be carried out before secondary degenerative changes occur. In case the patient is in collapse, appropriate treatment should, of course, be carried out before

she is subjected to operation. In the case here presented the attack had started 4 or 5 days before the patient entered the hospital, and her condition was extremely precarious it was felt that the improvement of her general condition by transfusion and by intravenous infusions of 10 per cent glucose prior to operation even though it involved further delay contributed to the favorable outcome.

The type of operation selected must, of course depend upon the pathology found. Supravaginal hysterectomy is usually indicated although at times a more conservative procedure such as myomectomy is the operation of choice.

SUMMARY

1. A case is reported of torsion of a fibromatous uterus occurring in a woman 62 years of age and producing acute symptoms and collapse. Pre-operative treatment consisted of transfusion and intravenous glucose infusions. Operation was supravaginal hysterectomy under local anesthesia, the patient recovered.

2. Approximately 140 cases have been reported in the literature, 8 being from the United States. The cases from the United States are abstracted together with 6 cases from other countries which have appeared in the literature since Pelgital's article in 1929.

3. In considering the pathology it is noted that the tumor responsible for the twist is usually large, and may be single or multiple sessile or pedunculated. The changes taking place in the uterus and fibroid depend upon the extent to which the circulation is cut off and vary from oedema and congestion to necrosis.

The torsion usually takes place at the isthmus the twist is commonly from left to right and may be through as few as 90 degrees or as many as 450.

4. In regard to the etiology there are a number of factors that are not clear certain facts, however may be noted. Before the rotation occurs, there is usually a thinning and stretching of the isthmus as the tumor increases in size, so that this structure forms a pedicle which may readily be twisted. Asymmetry in the growth of the tumor may be a factor in the torsion movements of the body may be important in initiating the twist.

5. The cases fall into two clinical groups one giving an acute, fulminating picture similar to that encountered in twists of an ovarian cyst or pedunculated fibroid, the second presenting mild symptoms which sometimes continue over a period of years.

6. Prompt operative treatment is usually indicated with appropriate pre-operative treatment to combat shock if this complication is present.

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CERVICAL NEUROFIBROMA

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TWO cases of cervical neurofibroma, recently encountered have renewed our interest in the subject and have prompted this review and study of 17 such cases in which operation was performed at The Mayo Clinic between July 1924 and January 1 1934. This group of cases is exclusive of those neurofibromata arising from the brachial plexus or the spinal cord. Writing of this paper is not undertaken with the expectation of presenting anything new rather, it is to re-emphasize points in connection with neurofibroma (particularly of the neck) which should be familiar to physicians. It is of importance to both physician and patient that this tumor be correctly understood.

ETIOLOGY

The etiology of neurofibroma is not definitely known, although in many instances there is to be found a most interesting familial background. Gardner and Frazer have reported a family of five generations with 217 members, in which bilateral deafness was transmitted as a mendelian dominant character. Thirty-eight members were affected 2 of whom came to necropsy and were proved to have bilateral acoustic neurofibromata. Fleming and Marvin have reported 3 cases of multiple tumors of peripheral nerves occurring in the members of one family although in 2 instances the tumors developed following trauma. There are others, as Gatch and Ritchey who although inclined to feel that heredity plays an important part in the formation of neurofibroma do not dismiss lightly the factor of trauma. Warthin Blodgett Brough and Lehman expressed the belief that neurofibromata are congenital in origin and are the result of some malformation of the ectoderm. In respect to etiology in the 17 cases of neurofibroma of the neck to be considered here 8 patients gave histories of malignant disease in their immediate families. The percent age of error however may be rather great, for we are unaware how many of these relatives gave microscopic proof of the malignancy nevertheless, it does seem significant that so many patients in this series apparently had blood relatives suffering from carcinoma or sarcoma.

In Case 17 there was a definite history of trauma preceding discovery of the tumor but the interval between injury and development of the tumor was not stated, and we feel that this is merely a coincidence.

PATHOLOGY

Grossly neurofibromata are rounded or spindle shaped tumors with smooth surfaces and of rather firm consistency. As a rule they are fairly well encapsulated but this is by no means constant. The cut surface is yellowish white and finely granular.

The microscopic anatomy of neurofibroma is characteristic and distinct. The cells are long and spindle shaped, and have a tendency to arrange themselves in bundles which produce a palisade effect. This palisading of the cells is one of the main distinguishing features of the tumor. The nuclei run parallel in long columns, and each nucleus lies on top of another one. In a few other places one gets concentric whorls, as in a meningioma (14). The nerve cells and fibers which are present may be scarce in proportion to the stroma of the tumor and hence, are difficult to recognize. Frequently the nerve fibers which are present may be so encroached on by the connective tissue that they become atrophic. Whenever the tumor arises from the specialized nerve tissue it may approach the character of a neuroma with a paucity of connective tissue framework. In other cases the tumor may arise from the connective tissue as a pure fibroma. In most cases, both connective tissues and nerve elements may be found with the former in preponderance. In some tumors the stroma is extremely loose and myxomatous. Mitotic figures and a marked change in the relationship of cells are seen in those tumors which are undergoing malignant degeneration.

Some idea of the difficulty in microscopic diagnosis encountered by those who are unfamiliar with these tumors is suggested by an incident in our series (Case 17). At operation, prior to the patient's admission to the clinic, the removed tissue was diagnosed in a state laboratory as malignant, and in another laboratory as keloid.



Fig. 1. Case 16. Hemorrhagic, cystic, degenerating neurofibroma.



Fig. 2. Case 16. Neurofibroma, showing characteristic arrangement of nuclei.

like" tissue. On operation at the clinic for recurrence, the pathologist was unable positively to identify the type of tissue from frozen sections and could state only that it was not malignant, until fixed sections had been recognized as characteristic of neurofibroma.

SYMPTOMS AND SIGNS

The symptoms of neurofibroma of the neck are, as a rule, not severe. The patient generally seeks relief because of the disfigurement or the worry which the growth causes, rather than because of discomfort. Of our 17 patients 9 made no complaint of spontaneous pain. The 8 remaining made complaints of pain of varied intensity. One referred to his pain as a dull ache in the tumor; 2 stated that they had moderate discomfort, which was aggravated by fatigue; 1 stated that the tumor was sensitive to changes in the weather; and 1 had been symptomless for 8 years, at the end of which time the tumor had begun to throb like a toothache. In but 1 case was there any radiation of pain, and this only when the patient was fatigued, at which time the pain extended down to the shoulder.

Preservation of function of the affected nerve in cases of neurofibroma is rather remarkable. In none of our cases, even in those in which tumors were large, was there any evidence of impaired function of the nerve. It must be remembered, however, that none of the tumors in this series

arose from large sensory or motor nerves. Gatch and Ritchey also have observed that nerves will withstand much abuse from pressure and stretching by a benign tumor, but that malignant infiltration into the nerve fibers soon destroys their function. This is in fact, the principal diagnostic feature of malignant degeneration of a neurofibroma, for sudden and rapid increase in size of the tumor is not proof of malignancy.

On physical examination neurofibromata are as a rule, discovered to be of rather hard consistency, to be regular in outline and more or less freely movable. The tumors in all but 2 of our cases were described as being firm or moderately hard. One was described as being rather soft, and another which had undergone cystic degeneration was fluctuant. Three of the tumors were described as having a 'malignant feel'. All of the tumors were smooth, save two which were slightly nodular. The mobility of the tumors varied somewhat but all were at least slightly movable. The cardinal sign of neurofibroma elsewhere in the body is limitation of motion in a direction parallel with the longitudinal axis of the affected nerve, whereas, there is freedom of motion transverse to the course of the nerve. This finding was not noted in a single one of our cases, probably because of the relative fixation of the surrounding structures, as well as the comparatively short course of the affected nerve between fixed points.

Although neurofibromata may cast a definite shadow in a roentgenogram (3) this shadow is by no means characteristic nor could it be distinguished from the shadow cast by any other soft or firm tumor.

DIFFERENTIAL DIAGNOSIS

There are a few features in differential diagnosis which should lead to suspicion of the presence of neurofibroma, provided the condition is kept in mind as a possibility. The other tumors of the neck from which it must commonly be distinguished, are the tumors resulting from lymphadenopathy, metastatic tumors, tumors of the salivary glands, branchial cysts, aberrant thyroid glands, tuberculomata, and such rarities as tumors of the carotid body. In but 5 of our 17 cases was a neurofibroma suspected before operation. None of these patients complained of neurologic symptoms, for the involved nerves in most instances were relatively unimportant sensory branches. Neurologic examination consequently was not as a rule carried out. The majority of the diagnoses were made in other than the neurologic section of the clinic. The operation

was likewise as a rule done by a general rather than a neurologic surgeon.

To distinguish between neurofibroma and tumors resulting from lymphadenopathy is occasionally rather difficult. As a rule, however when a tumor of the neck results from lymphadenopathy, study of the blood picture, the presence of enlarged lymph nodes elsewhere in the body and, particularly, detection of a discrete and separate mass making up the tumor of the neck, should lead to proper evaluation of the underlying condition. Especially if one considers the lack of general symptoms and the paucity of complaints relative to the local condition in cases of neurofibroma.

The differential diagnosis between neurofibroma and metastatic carcinoma should offer little real difficulty. Although neurofibromata are firm tumors, and often are described as imparting to the touch a sensation like that imparted by malignant tissue still they are as a rule, more discrete, better circumscribed, more freely movable, smoother and softer than carcinomatous nodes. The loss of weight and cachexia that accompany carcinoma are absent in neurofibroma and of cardinal importance is the absence of any discernible primary source of malignancy. The age of the patient may be of some aid in making the distinction. Although 5 of our patients were more than 50 years of age when they were first aware of the tumors, the average age of the 11 remaining patients was but 26.4 years, the youngest patient in the group was 15 years of age and the oldest, 44. The average age of the patients of the entire group was 34.8 years, which is definitely much younger than the average age of sufferers from carcinoma. These patients had known of their tumors for an average of about 6 years before they came to operation. The rate of growth is, as a rule, steady and gradual although in one of our cases the tumor grew to the size of a fist within 18 months, and in 2 others the rate of growth was described as rapid. These features of slow growth and long duration should be very helpful in distinguishing neurofibromata from carcinomata, provided the patient has permitted himself to go for a long time without biopsy.

The distinction between neurofibroma and branchial cyst should be relatively easy unless, as in one of our cases, the neurofibroma has undergone cystic degeneration. Branchial cysts are, as a rule encapsulated, discrete, fluctuant or cystic tumors, which may be freely movable or loosely attached to the deeper structures. Carp and Stout noted that a cold or sore throat fre-

quently preceded their appearance or increase in their size. Pain in branchial cysts is unusual.

Lateral, aberrant thyroid glands are, in reality rather rare hence, their diagnosis is difficult. This diagnosis was erroneously suggested in 2 of our cases. These tumors resemble neurofibromata in that often they do not cause symptoms, their growth is slow as a rule, and they are not tender. The consistency of aberrant thyroid glands is not constant they may be firm or soft. Their only distinguishing feature is that they are likely to increase in size at puberty and to fluctuate in size during menses. These tumors are said by Lawton to be radiosensitive, and as this feature is not shared with neurofibromata it might be of diagnostic aid.

The diagnosis of tuberculous lymphadenopathy usually can be made readily on the basis of presence of fever positive tuberculin reactions, caseous lymph nodes or discharging sinuses. Neurofibromata may resemble tumors of salivary glands, especially those of the submaxillary glands. This resemblance appeared once in our series. In 3 of our cases (Cases 5, 6 and 7) there were small neurofibromata elsewhere in the body although the tumor in the neck in each instance was the predominant tumor. These cases of multiple neurofibromata fall into the classification of von Recklinghausen's disease.

TREATMENT

The treatment of neurofibroma is surgical removal as soon as the presence of the tumor is discovered. These tumors are potentially malignant they will recur if not wholly removed they are disfiguring and in addition the difficulties in arriving at a correct diagnosis necessitate microscopic confirmation. These tumors are not radiosensitive hence, roentgen-rays and radium are of no avail in treatment. Two of our patients underwent treatment by roentgen-rays prior to their admission to the clinic, without any appreciable effect on the neurofibromata. Flatau and Sawicki reported a case in which a neurofibroma was unaffected by both roentgen-rays and radium.

Surgical removal of neurofibromata should be instituted as early in the course of the disease as possible, for complete extirpation of the tumor means permanent cure. Delay in operation may permit such growth and extension of the tumor as to make complete removal impossible and recurring tumors, necessitating repeated operations, will result.

Four of our patients had had neurofibromata incompletely removed before their admission to

the clinic, with the result that secondary operations for recurrences were necessary. One of our cases represents well the danger of delay in surgical removal of these tumors. The patient first noted slight swelling in the neck in 1929. For 2 years she was given treatment with roentgen-rays and radium by her physician at home after which surgical intervention was advised but complete removal of the tumor was not effected. The remaining tumor tissue increased in size more rapidly and within 11 months it had reached the size of a hen's egg (about 6 centimeters in length) most of the enlargement having taken place in the last 4 months of this period. At secondary operation extensive dissection was necessary to remove the recurrent growth, which had extended underneath the internal jugular vein and the internal carotid artery from its apparent point of origin in the descending hypoglossal nerve.

Neurofibromata should be completely removed because, in addition to the dangers of recurrence, there is also the inherent possibility of malignant degeneration. Although this phenomenon was not encountered in any of our cases, it is well vouched for in the literature. Gatch and Ritchey saw occasional mitotic figures and a small portion which appeared to be a sarcoma, in a neurofibroma which they removed from a patient's neck. Gibberd reported an interesting case of Davies' in which a neurofibroma of the cervical sympathetic nerves was removed, and an adjacent lymph node was found to contain a deposit which was histologically identical with the main tumor. This patient had no signs of recurrence 3 years after the operation. Lemon, in speaking of mediastinal tumors, stated that neurofibromata of the mediastinum are potentially malignant in two ways (1) they may take on periods of activity and grow to such an extent that they produce symptoms of pressure and (2) they may become invasive, metastatic, and malignant in cellular characteristics and produce death in the manner of sarcoma. Gardner and Frauder in tracing a family afflicted with a mendelian transmission of bilateral neurofibromata of the acoustic nerve, observed marked increase in malignancy with each transmission in the group. Whereas the members of the second generation averaged 75 years of life those of the fifth generation averaged only 28 years. Flatau and Sawicki reported a cervical neurofibroma containing many mitotic figures. This tumor recurred a few months after its partial removal. Blodgett, Brough, and Lehman asserted that solitary neurofibromata have a marked tendency to undergo sarcomatous degeneration.

The technical difficulties met during operation may be great or small and often cannot be well evaluated before the incision is made. Frequently important structures must be sacrificed in the all important effort completely to remove the tumor. In this respect it may be wise to warn the patient of this possibility before operation. In but 6 of our 17 cases was the neurofibroma so situated and of such size as to be easily removed without considerable dissection to separate it from important structures. One was firmly attached to the floor of the mouth, 1 extended back of the angle of the mandible, 4 extended beneath the carotid sheath and were adjacent to the carotid arteries or internal jugular veins. One extended beneath the clavicle, 1 was beneath a submaxillary gland, which had to be sacrificed to effect removal of the neurofibroma. One was beneath the cervical nerves. Adson has given some valuable suggestions regarding the surgical procedure of choice in dealing with neurofibromata. He has recommended complete removal of the tumor including resection of the involved nerve (1) when the nerve is small and of no significance (2) when the nerve is a sensory one and (3) when the tumor is malignant. He recommended intracapsular removal of the tumor if it occurs in a mixed nerve and the tumor is benign. He stated that a fresh tissue study of the tumor before the completion of the operation is essential to determine the best operative procedure.

The complications of operation for neurofibroma of the neck lie mainly in destruction of the nerve from which the neurofibroma arises. One of our patients, whose neurofibroma arose from the cervical sympathetic nerves had a Horner's syndrome after operation. This sequel also has been reported by Gibberd. Another patient, whose neurofibroma apparently arose from the left descending hypoglossal nerve and extended into the carotid sheath, had contraction of the left pupil after operation. In another case, the neurofibroma had been thought, at operation prior to the patient's admission to the clinic, to arise from the left vagus nerve. On examination at the clinic, it was felt that the patient had an irritable heart resulting from sacrifice of the left vagus nerve. The left vocal cord was also fixed in the median line. After the recurring tumor had been removed at the clinic, slight left exophthalmos, but no Horner's syndrome developed. The patient's voice improved surprisingly after removal of the tumor which was pressing on the pharynx. Another patient, a man aged 26 years had a very extensive neurofibroma in the right side of the neck, extending below the

clavicle and into all fascial planes, and the spinal accessory nerve was intimately involved. Two years after operation the man was still suffering from some loss of function of the right arm, resulting from necessary sacrifice of nerves.

REPORT OF CASES

CASE 1. A man, aged 58 years, presented himself at the clinic in July, 1924. He gave the history that his father had died of carcinoma of the stomach. He stated that for 8 years a tumor had been present on the right side of his neck. The tumor had not caused symptoms, the rate of growth was not stated. July 31 a myxomatous neurofibroma, measuring 3 by 3 centimeters, was removed from the posterior triangle on the right side of the neck. In a letter dated August, 1933 the patient stated that the tumor had not recurred.

CASE 2. An unmarried woman, aged 22 years, came to the clinic in January, 1925. She stated that her brother had died of Hodgkin's disease. For the past 2 years, the left side of her neck had gradually increased in size. During the previous 3 months the growth had been a little painful. On examination, a firm, somewhat irregular freely movable tumor was discovered in the left side of the neck. February 3 a neurofibroma, measuring 4 by 4 by 3 centimeters, was removed. Apparently it had developed in the left descending hypoglossal nerve and had worked its way beneath the internal jugular vein and internal carotid artery, the tumor apparently lying in the carotid sheath. There was contraction of the left pupil after operation.

CASE 3. A man, aged 35 years, was seen at the clinic in July, 1925. He stated that his mother and his grand mother both had died of carcinoma of the stomach. He gave the history that in 1921 one eye had been enucleated for melanotic sarcoma. At the time of his examination, a carcinoma of the rectum was found, along with some firm nodules in the left side of his neck. Biopsy of these nodules revealed neurofibroma. He subsequently successfully underwent operation for his rectal growth and apparently was in good health until March, 1933 when he died presumably from metastasis of the carcinoma.

CASE 4. A man, aged 34 years, presented himself at the clinic in September, 1925. He stated that his mother had died of sarcoma. A tumor had been present on the right side of the neck for 8 or 9 years. He stated that the tumor had not increased in size during the past 6 years. On examination a hard nodule was discovered in the right anterior cervical region. The nodule seemed to be attached to the hyoid bone. At operation, September 5 the nodule was removed and was discovered to be a neurofibroma. In 1933 the patient was admitted to an asylum for the insane, but there apparently was no recurrence of the growth.

CASE 5. An unmarried woman, aged 18 years, came to the clinic in August, 1926. She stated that for 3 years a painless, slowly enlarging tumor had been present in the right side of the neck. The rate of growth had been unaffected by local applications of iodine. On examination, a firm, irregular tumor was discovered. The tumor apparently was attached to the spinal column. At operation August 30, multiple neurofibromata were removed from the right posterior cervical region. The largest measured 7 by 1 centimeters, and the smallest, 3 by 4 millimeters. The tumor originated near the transverse processes of the fifth and sixth cervical vertebrae. In a letter dated August, 1933 the patient stated that the tumor had not recurred.

CASE 6 A man, aged 31 years, entered the clinic in September 1936. He stated that a tumor had been present in the right upper portion of the neck for 12 or 14 years, and had been increasing in size, but very slowly. The tumor gave no symptoms, and on examination was described as being rather soft. On September 24, a neurofibroma, measuring 8 by 5 by 3 centimeters, was removed from the right upper cervical region. The tumor extended back to the angle of the mandible. A small neurofibroma, measuring 3 by 1 by 1 centimeters, also was removed from the left thoracic wall. In a letter from the patient, received in August, 1935, he stated that the tumor had not recurred.

CASE 7 A man, aged 26 years, was seen in the clinic in January 1927. He stated that his mother was suffering from a carcinoma of the stomach. He gave the history that for 4 years there had been progressive swelling of the right side of the neck. On examination a large, firm tumor the size of a grapefruit (about 12 centimeters in diameter) was found on the right side of the neck. There were a few scattered, small subcutaneous nodules elsewhere on the body. At operation, January 1, a very extensive neurofibroma, weighing 240 grams was found. This tumor ran into all of the fascial planes below the clavicle and seemed to be attached to the side of the cervical portion of the spinal column. It was intimately involved with the spinal accessory nerve. Following operation there was some weakness of the right arm, resulting from the necessary sacrifice of nerves in removal of the neurofibroma. The patient's father 5 years after operation, reported that the muscles of the patient's right arm still were somewhat weak.

CASE 8 A married woman, aged 57 years, presented herself at the clinic in January, 02. She stated that her grandmother and one aunt had died from carcinoma. She gave the history that 6 years previously she had experienced some pain in the neck when her head was tilted backward. This pain had been of short duration at that time and she had been symptom-free for the following 9 years, until recently when, in the back of her neck a pain had developed which she likened to a throbbing toothache. A small, movable tumor was palpable in the median line, over the 4th cervical vertebra. At operation, February 1, a neurofibroma measuring 1 by 1 centimeter was removed from the ligamentum nuchae. The tumor was very hard and fibrous and was well incorporated in fibrous tissue. In a letter received from the patient in August, 1933 she stated that the tumor had not recurred.

CASE 9 A boy aged 15 years, was brought for examination in September, 08. The history was that for a year the right submandibular region had been gradually increasing in size. Apparently there had been remission in the rate of growth. The tumor did not cause symptoms, and on examination was found to be a discrete, moderately hard, barely movable mass, the size of a pigeon's egg (about 4 centimeters long). At operation, September 1, a neurofibroma weighing 70 grams was removed. It was situated in the right submandibular space, displacing the submandibular salivary gland downward and outward. It was firmly attached to the floor of the mouth there was no line of cleavage. The patient returned to the clinic 8 years later, in 1927 and stated that during the past 3 years he had noted recurrence of the tumor. The rate of growth had been slow during the first year, and rapid during the last year. July 6, he was operated on again, and a large, recurrent neurofibroma, extending up to the base of the skull, was removed. August 6 he was again operated on, and a small, recurrent neurofibroma was removed from the floor of the right side of the mouth. He was given a course of treatment by roentgen-rays, and in a letter received in March, 1930, the patient stated that there had been no recurrence of the tumor.

CASE 10 A married woman, aged 58 years, entered the clinic in March, 1928. She stated that a tumor had been present in the left cervical region for 40 years. For 3 years it had not perceptibly increased in size, but in the past 8 months the rate of growth had been rapid. There had been no symptoms from the tumor. On examination, a firm, smooth, slightly movable tumor with a "malignant feel," was found in the left side of the neck. At operation, March 6 a neurofibroma, measuring 9 by 6 by 6 centimeters, was removed. It rose high behind the bifurcation of the carotid artery and was pushing the artery forward. It was incorporated in the deep cervical fascia, was well encapsulated, and was easily enucleated. In a letter received from the patient in 1931 she did not mention recurrence.

CASE 11 A man, aged 50 years, presented himself at the clinic in March, 1930. He gave the history that for 4 or 5 years a swelling had been present in the left posterior cervical region. The swelling was sometimes tender. On examination it was discovered to be hard and discrete. On removal, March 12, the tumor was found to be a neurofibroma, measuring 2 by 2 by 1 centimeter. In a letter, dated August, 1933, the patient stated that the tumor had not recurred.

CASE 12 A married woman, aged 36 years, entered the clinic in April, 1930. She stated that her grandfather had had a carcinoma of the breast. For 9 years the patient had had a small tumor in the left side of the neck. The rate of growth apparently had been slow, but the patient thought that there had been some increase in size during her two pregnancies. Occasionally there was pain in the swelling, with some extension of pain down to the shoulder. On examination, the tumor was found to be firm, freely movable, and distinctly tender. At operation, April 20, a small, encapsulated neurofibroma, measuring 3 by 3 centimeters, was found in the posterior triangle on the left side of the neck. The tumor was freely movable, and was attached only to the fascia. In a letter received from the patient in August, 1933 she stated that the tumor had not recurred.

CASE 13 A youth, aged 28 years, presented himself at the clinic in June, 1920. He stated that for 2 or 3 months there had been a steadily growing, symptomless tumor at the right angle of the jaw bone. On examination the tumor was found to be hard, rather irregular, slightly movable, and situated at the right angle of the mandible. Two small lymph nodes were near it. The tumor was described as having a "malignant feel." At operation, June 9, a neurofibroma, measuring 5 by 3.5 centimeters, and weighing 30 grams, was removed from beneath the submandibular gland, which had to be sacrificed. In a letter received from the patient in August, 1933 he stated that the tumor had not recurred.

CASE 14 A married woman, aged 56 years, came to the clinic in December 1931. She stated that for 3 years the right side of her neck gradually had increased in size. She experienced a sensation of strain in this region when she was tired. At operation, December 4, a myxomatous, degenerating neurofibroma was removed.

CASE 15 A married woman aged 47 years, entered the clinic in August, 1931. She stated that in 1929 a tumor had developed in the left side of her neck. Growth of the tumor had been rapid and it had approached the size of a fist (about 8 centimeters in diameter) within 18 months. A course of treatment by roentgen-rays had been given elsewhere, without effect on the tumor and in August, 1931 a huge neurofibroma of the vagus nerve had been removed elsewhere. Following this operation a good sized lump had remained above the scar which had not increased much in size until April, 1932, when it had started

to grow and had become the size of a hen's egg (about 6 centimeters long) by August, 1933 when she reported to the clinic. There was some pain when pressure was exerted on the growth, but otherwise there were no symptoms. The tumor had a 'malignant feel' and was slightly movable. The left vocal cord was fixed in the median line, and an irritable heart and rapid pulse were felt to be results of sacrifice of the vagus nerve at the previous operation. The patient was operated on at the clinic on August 4, and a very large neurofibroma, measuring 9 by 6 by 4.5 centimeters, was removed. It apparently arose from the third cervical sensory nerve and necessitated wide dissection for its removal. The carotid vessels, the mucous membrane of the nasopharynx, the carotid gland, and the transverse cervical processes were exposed during its removal. After operation there was slight left exophthalmos, but no Horner's syndrome. In a letter received from the patient in August, 1933, she stated that she was in good health and that her voice was improving.

CASE 16. A married woman aged 38 years, was admitted to the clinic in October, 1932. She stated that her mother had had a carcinoma of the uterus. She gave the history that for 4 years there had been progressive swelling of the left side of the neck. This had been diagnosed tuberculous elsewhere, and a course of treatment by roentgen-rays had been given without any effect on the tumor. The patient complained of a drawing sensation in the neck, and stated that it was sensitive to changes in the weather. On examination, the tumor was found to be smooth, movable, and slightly fluctuating. At operation, October 21, a deeply placed, hemorrhagic, cystic, degenerating neurofibroma was removed without rupturing it (Figs. 1 and 2). A left Horner's syndrome developed postoperatively.

CASE 17. A girl, aged 3 years, was brought to the clinic in April, 1933. Her mother stated that in January 1932 the patient had fallen and had struck her neck. A short time afterward, a firm mass had been felt in the injured region. An ointment had been applied, but the mass had continued to increase in size, and in November 1932 elsewhere, the tumor had been removed. The tissue had been reported to be malignant by one laboratory and of a keloid nature by another. The tumor reappeared in January 1933 and continued to grow until April 10, 1933 when at the clinic a hard somewhat movable recurrent tumor measuring 3 by 3 centimeters, was cleanly removed from the left upper cervical region. A drainage tube was left in place, through which irradiation with radium was instituted. Microscopic diagnosis of the tumor by frozen section, revealed a benign tumor the exact nature of which could not be ascertained. Fixed sections disclosed that the tumor was a neurofibroma. In a letter from the mother received in October 1933 she stated that the tumor had not recurred.

CONCLUSIONS

We have attempted to emphasize certain important points relative to cervical neurofibroma, as follows: (1) the hereditary factor in the etiology of neurofibroma of the neck cannot be lightly disposed of even though it is not proved; (2) a wide variety of nerves in the cervical region may

be affected by neurofibroma, (3) neurofibromata are potentially malignant, sudden increase in rate of growth or long duration are not necessarily criteria for malignant change; (4) differential diagnosis is usually made from the various forms of lymphadenopathy, metastatic tumor, tumor of the salivary glands, branchial cyst, aberrant thyroid gland, tuberculoma, or tumor of the carotid body; (5) results of treatment by roentgen-rays or radium have not been satisfactory; (6) treatment of cervical neurofibroma is radical surgical removal.

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THE TOXEMIAS OF PREGNANCY¹

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THE toxemias cause the death of approximately 4,000 women in the United States each year. The general mortality in eclampsia is 20 per cent; therefore, at least 20,000 women must have the disease each year. The ratio of eclampsia to the larger group of non-convulsive toxemia varies from 1 to 5 to 1 to 15; therefore at least 100,000 women each year in the United States have their pregnancies complicated by toxemia. All follow-up studies indicate that many of these toxemic women are partly incapacitated or that their life expectancy has been definitely shortened because of irreparable injury to the kidneys, vascular system, or heart.

During the past 9 years I have been interested in the toxemias of pregnancy and have made various investigations. I have done experimental work on both humans and animals. These studies were started with Dr. Schwarz in St. Louis and have been continued in Chicago with Dr. Adair and Dr. DeLee. I have had unusual opportunities to examine, study and treat at least 700 toxemic patients, of whom 75 had eclampsia. Prior to 1934 we had examined 3,688 samples of blood from approximately 400 toxemic patients. Each specimen was analyzed on an average for twelve substances, and special emphasis was placed on repeated determinations on the same patient. About 2,000 specimens of urine from approximately 300 patients also have been analyzed for various constituents.

Many obstetricians state that we have learned nothing concerning these diseases but a brief résumé of the more important data, obtained by chemical analysis of the blood and urine, various renal function tests, follow-up studies, and observations on large groups of patients treated with definite routines, indicate that our knowledge of the toxemias of pregnancy is increasing slowly.

Repeated chemical analyses of the blood of these toxemic patients indicate that:

The alterations in blood and plasma volume in eclampsia and pre-eclampsia, as indicated by changes in serum protein, hematocrit and hemoglobin determinations, are identical, thus linking these two conditions together and definitely separating them from the patient with nephritic toxemia or essential hypertension.

In the majority of patients with edema, the internist usually believes that its presence is due

to a low serum protein. Practically all of the patients with toxemia of pregnancy have a serum protein above 5 grams per cent and although the albumin fraction is lowered the decrease is not sufficient to be the cause of the edema.

Despite the high blood pressure, edema, albuminuria, and other signs of kidney involvement, we found that in about 3,700 analyses of blood, the non-protein nitrogen was 40 milligrams per cent or more in only 67 blood specimens from approximately 20 patients. The toxemia is not due to a retention of urea, ureic acid, creatinine or amino-acids.

The hemoglobin is a little less than the average normal for pregnancy and decreases still more after delivery. Venesections are therefore not only contra-indicated but actually dangerous.

The acid base balance is altered slightly but because of compensatory changes there is no danger as a rule, of acidosis or alkalosis.

With the exception of hemoglobin, the routine determination of all blood constituents is useless. Each patient presents a different problem and if chemical examination of the blood is thought advisable, specific determinations should be made.

Examination of the urine indicates that:

The pregnant woman, probably because of the excess of amount of water in her tissues (physiological edema) is able to excrete urine with an average specific gravity of only 1.022 after a 15 hour fast. With longer fast periods or after delivery or death of the fetus, she is able to excrete urine with a specific gravity of 1.030 or even higher. The average specific gravity for the toxemic patient is approximately 1.013. As a rule, if the patient is able to excrete urine with a specific gravity of 1.010 or more and the 24 hour volume of urine is 1,000 cubic centimeters or more, the blood non-protein nitrogen and urea nitrogen will not be increased. When the 24 hour volume of urine is less than 1,000 cubic centimeters and the specific gravity is less than 1.010, it is advisable to determine the non-protein nitrogen.

The microscopic examination of the urine if done by the Addis method, which entails the examination of the sediment from a concentrated specimen collected over a known period of time has been of the utmost value for diagnosis, prognosis, and treatment.

¹Read at meeting of the Chicago Gynecological Society, January 29, 1934.

The phenolsulphonephthalein test in approximately 60 toxemic patients was less than 50 per cent for a 2 hour total in only 5 cases, and has not been used by us since 1929.

The urea concentration in the urine after the administration of 15 grams of urea by mouth in approximately 50 toxemic and normal pregnant patients was rarely over 2 per cent (normal 2 to 4 per cent) and, therefore, this test is no longer used by us.

The urea clearance test of Van Slyke has been used about 400 times in 150 patients. We are attempting to determine its value at present. We can state, however, that if the clearance is determined after delivery and found consistently to be less than 20 per cent of the normal, we know that the life expectancy of the patient is but a few years at the most.

The determination of the glomerular filtrate by the Rheberg creatinine method has been used in too small a number of patients to warrant any conclusions.

The kidneys of many eclamptic and pre-eclamptic patients function normally within 24 hours post partum, thus precluding any organic lesion and presupposing a functional one. A spasm of the arterioles, decreasing or even stopping the blood flow through the glomeruli, would explain many of the findings and would, if continued too long, result in permanent kidney pathology and decreased function.

We believe that the toxemic patients should be considered as a group and that they should be divided arbitrarily into convulsive, or eclampsia (convulsions and/or coma), and non-convulsive toxemia. The latter group is composed of all patients who have albuminuria, hypertension, or oedema during pregnancy. The parity of the patient, history, time of onset of symptoms, various blood and urine examinations, and renal function tests, especially several weeks or months after delivery, are considered in deciding whether or not the condition was one of pre-eclampsia, pregnancy with chronic nephritis, or essential hypertension. The data obtained in the laboratory are considered in arriving at a final diagnosis, but they do not make the diagnosis. We believe that the patient with the so called low reserve kidney either has a chronic nephritis or an essential hypertension. The statement made by some observers that the condition does not progress is open to criticism. The very fact that this statement is made implies periodic observation of the patient which means constant supervision of diet, rest, and elimination. In addition the large inherent technical error in the various tests may

mask the damage to the cardiovascular renal system which each pregnancy undoubtedly is producing in these patients. It is a common observation by internists that rest, diet, and elimination seemingly will arrest and many times apparently cause improvement in patients with nephritis or hypertension.

An examination of the past obstetrical histories of many patients, who die during or shortly after labor without an apparent primary cause, indicates that these patients usually had mild symptoms of toxemia with each pregnancy. The result of the repeated toxemias has been a slightly damaged heart or kidney or an anemia. An additional strain such as a prolonged labor, hemorrhage, infection, or a mental shock has been the proverbial straw which broke the camel's back. The prevention of future pregnancies and the treatment of the anemia or the cardiovascular system would undoubtedly have prolonged these patients' lives.

Vasomotor lability appears to be a significant index of diagnostic and prognostic value. This is determined by permitting a patient, under basal conditions to immerse her hand in water at plus 1 degree centigrade and observing the fluctuations in blood pressure every 30 seconds for 2 minutes. If, after repeated tests, the systolic blood pressure shows a rise of 40 millimeters of mercury or more before or after delivery, the patient has an impaired vascular system which may or may not involve the kidneys.

In Table I are summarized the number of severe and moderately severe toxemic patients admitted to the Chicago Lying in Hospital over a period of 2 years and 7 months. During this time there were 6,968 deliveries exclusive of abortions. There were 327 hysterotomies during this period. The majority of course, were cesarean sections of the laparotrachelotomy type.

The number of toxemic patients is large (6.7 per cent) in proportion to the number of deliveries, even if the number of home deliveries is included. There were 4 immediate deaths, 2 of which were from hemorrhage (private patients), 1 from infection, and 1 from an acute nephritis with infection who died undelivered. The low maternal mortality is due to an early termination of pregnancy, either by induction of labor or cesarean section if near term, or by hysterotomy if discovered early in pregnancy. Thus, in 196 patients (45 per cent) labor was induced or the pregnancy terminated by an operative procedure. If labor cannot be started by medical means, our results seem to indicate that the insertion of a bag and/or rupture of the membranes are the most efficacious methods.

TABLE I.—NON-CONVULSIVE TOXEMIA OF PREGNANCY CHICAGO LYING-IN HOSPITAL OVER A PERIOD OF 2 YEARS 7 MONTHS ONSET OF LABOR, VARIOUS METHODS OF INDUCING LABOR AND TERMINATING PREGNANCY

	Total
Number of patients	413
Number of maternal deaths	9
Within 7 weeks postpartum	4
Within 6 months postpartum	4
Within 1 year postpartum	
Number of fetal deaths, after 6 weeks' gestation	15
Induction of labor	24
Medical	34
Ruptured membranes	20
Intra-uterine gaseous packing	7
Intra-uterine bag	1
Intra-uterine gaseous bag	
Intra-uterine gaseous, rupture of membranes	
Ruptured membranes, bag	
Therapeutic abortion	41
Laparotomy	
Indications: Toxemia — contracted pelvis, previous cesarean section, premature, postmature, abruptio placentae	
Weight of fetus	
over 4000 grams or over	
3500-4000	
3000-3500	
2500-3000	
2000-2500	
1500-2000	
1000-1500	
500-1000	
400	
Total	15
Placental deaths	45
Within 7 weeks postpartum	
Within 6 months postpartum	

There were 85 laparotomies done on toxemic patients, the majority of whom had severe symptoms. The indication for the laparotomy was rarely the toxemia *per se*. Usually, contributory factors were present as indicated. There was only one immediate death, which occurred in a toxemic patient who had a complicating cardiac decompensation, and several of us believe that the patient might have survived if the operation either had been delayed or not done. In this operative group only one baby weighing over 1500 grams, was lost. These babies usually are premature maybe toxic, and in many cases are more valuable to the parents than babies of patients without toxemia. We ascribe the low fetal mortality to the minimal birth trauma produced by cesarean section, as contrasted to the physiological trauma (Ehrenfest) produced by delivery through the natural passage. The prevention of future pregnancies by operative sterilization was an additional indication in a number of

cases. We believe that in these patients, because of the unreliability of contraceptive methods, one is often justified in subjecting them to the additional risk of a laparotomy. A small number of pregnancies was terminated and the patients sterilized by hysterectomy. This certainly is the easiest and safest method, but it seems to me that these patients maintain a higher blood pressure and have more headaches and other minor disturbances than those sterilized by tubal resection.

The general plan of treatment for the non-convulsive toxemia of pregnancy is as follows:

Rest. We advise absolute bed rest with the additional use of sedatives, such as luminal, bromide, amytal, etc.

Diet. Limitation of protein, fat, and salt. The fluid balance is watched carefully. The urine should form at least 80 per cent of the intake. *Types of diet.* For the eclamptic the diet consists of fruits and fruit juices. This is an alkaline diet because of the high content of potassium and sodium. It can be maintained from 5 to 10 days and is used in severe cases. As a rule, no limit is placed on the intake unless there is some evidence of cardiac decompensation.

For the pre-eclamptic, the diet consists of protein (60 grams) fat (50 grams) carbohydrate (400+ grams) and is salt poor.

For the patient with nephrosis the diet is similar to that for the pre-eclamptic, except that the protein content is increased to 100 to 150 grams. This diet is used if there is a marked albuminuria (5 grams or more per 24 hours) over a long period of time. Rarely used during pregnancy.

Drugs. Luminal is given in doses of $\frac{1}{4}$ to $\frac{1}{2}$ grains three times daily by mouth, sodium luminal, in doses of 2 to 5 grams, subcutaneously two or three times daily if convulsions seem imminent.

Diuretics. Mithramycin sulphate, 60 cubic centimeters of a 50 per cent solution, is given by mouth and not repeated. Enemata of 160 cubic centimeters of a 50 per cent solution are used if edema is marked. Castor oil, phenolphthalein, or some other mild cathartic for daily use.

Edema. Eclamptic diet is adhered to and the water balance maintained. Occasionally fluids are limited to 1,000 cubic centimeters, or even 800 cubic centimeters, per 24 hours. Saltyrigan and potassium have been of no value. Ammonium chloride sulfate in 6 to 10 gram doses daily has been of use.

Oliguria or anuria. The intravenous injection of hypertonic glucose solutions.

Usually 500 cubic centimeters, of a 50 per cent solution, is administered over a period of from 30 to 60 minutes and repeated two or three times daily. Occasionally 1,000 cubic centimeters of a 50 per cent solution is used.

If the 50 per cent solution fails to produce a diuresis, from 500 to 800 cubic centimeters of a 30 per cent solution is injected two or three times daily.

In patients with anuria or with cardiac decompensation, from 100 to 300 cubic centimeters of a 50 per cent solution is injected two or three times daily.

Glucose anuria solution. If a diuresis cannot be produced with glucose solution the injection of from 500 to 1,000 cubic centimeters of a 6 per cent acacia in normal saline is of value.

Magnesium sulphate solution. The slow intra-venous injection of from 100 to 300 cubic centimeters of a 1 per cent solution is of value in producing a diuresis if glucose injections fail.

Venesection and plasmapheresis are no longer used.

In Table II are summarized the data for the eclamptic patients. There were only three cesarean sections with a questionable indication for one, performed in 15 antepartum cases of eclampsia. The one maternal death occurred in a patient who walked to the delivery floor at 3:30 p.m., began having convulsions at 4:00 and died at 5:00 p.m.

Of the 438 toxemic patients, 90, or 20 per cent, gave a history of previous toxemia. Twenty nine patients who gave a history of convulsions in a previous pregnancy were delivered by us, and 26 or 90 per cent, had some evidence of toxemia in the present pregnancy.

In general, the rules which we attempt to follow are:

If the pregnancy is less than 28 weeks gestation, and if after a period of from 7 to 10 days observation, study and treatment, the symptoms and signs continue or become worse, the pregnancy is terminated. If the patient has one child or more, we advise against future pregnancies. If postpartum studies indicate a permanently impaired cardiovascular renal system.

If the patient is seen after the period of 28 weeks gestation, and, if after from 7 to 10 days' observation and treatment, there is no improvement, the pregnancy is terminated. However if there is any amelioration of the signs and symptoms with bed rest, diet, elimination, and sedatives no interference is indicated. Many of these patients can be carried to term and delivered through the natural passage.

An increase in blood pressure, an increase in the amount of albumin or edema, a decrease in visual acuity or amaurosis, jaundice, or the development of an oliguria or anuria warrants immediate termination of pregnancy.

The occurrence of convulsions in association with other evidence of toxemia warrants the termination of pregnancy unless the fetus dies *in utero*. I have not seen or read reports of a true case of severe intercurrent eclampsia in which the baby was born alive.

I believe that we will always have toxemias of

TABLE II.—ECLAMPSIA CHICAGO LYING-IN HOSPITAL OVER A PERIOD OF 2 YEARS, 7 MONTHS DELIVERIES—6 968 WITHOUT ABORTIONS—WITHOUT HOME SERVICE

	Total	Private	Ward
Number of patients	50	4	46
Mild	10	4	16
Severe	12		11
Antepartum	5		15
Postpartum	5	4	1
Induced labor	14	8	1
Cesarean section	5		4
Mortality			
Maternal	1	0	1
Fetal	2	5	8

pregnancy but proper rest, elimination, and diet will reduce the incidence. Preconceptional, prenatal, and postnatal care are of the utmost value in lowering the incidence and mortality of toxemia.

The mortality due to the toxemias of pregnancy will not be decreased until a rational campaign, even more widespread than that devoted to cancer, is instituted. The public then will become cognizant of the extreme importance of the toxemias of pregnancy, and funds and material will become available for study. Because of the relative scarcity of patients, the research work will have to be carried out in the various cities and districts in specified hospitals according to designated plans suggested by a central organization, whose membership may be composed of men selected by the various medical schools and special obstetrical societies. Thus, within the period of 1 or 2 years, all of the various types of therapy can be tried out and the most efficacious instituted with a resultant decrease in mortality. Similarly, the various theories, as to the etiology, can be investigated on a scale large enough to indicate their value. Within 10 years the cure, cause, and prevention of eclampsia and allied toxemia would be known.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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OCTOBER, 1934

THE BATTLE OF THE PROSTATES

SOMETHING over a year ago I made bold to suggest in these columns that the transurethral method of attack upon the obstructing prostate had achieved an important position in the field. I suggested at that time that the procedure was surrounded by technical difficulties, and that there was grave danger that in inexperienced hands disaster would occur. I further expressed the apparently futile hope that the operation would be allowed to develop naturally and be not too generally adopted. A year has now elapsed and we are in a position further to survey progress.

In its recent developments two types of technique have been used: one what may be called the Young, Caulk Bumpus type, the other the Stern, Davis, McCarthy type. The former method depends upon cutting away portions of the prostate with a circular knife introduced through the sheath, the bleeding being controlled by touching up the bleeding points under sight. This method involves a minimum of coagulation of tissue. The latter method depends upon the removal of tissue by

means of a wire loop charged with a very high frequency current. Bleeding is further controlled by direct coagulation. It will be noted that in the first of the two types there is relatively little coagulation and consequently relatively little danger of deep necrosis, which may later be followed by secondary hemorrhage when the slough separates. In the second method, particularly in the hands of a less skilled surgeon, relatively large amounts of coagulation may occur, causing the death of a considerable amount of tissue which is not removed.

During the last year these operations have been very extensively employed. The Davis-McCarthy method has been selected by the majority of operators because the instruments used are similar to the cystoscopes with which they are familiar and it does not therefore require the learning of new methods. The Caulk Bumpus method utilizes instruments with which few even trained urologists are familiar and which they are therefore reluctant to use. A survey of the last year's work in this country appears to me to warrant the conclusion that in the hands of those previously experienced the operation has lived up to its promise. On the other hand, as was to be feared, there have come from many quarters reports of poor results and serious accidents centering chiefly around the two complications of secondary hemorrhage and infection. It is proper, perhaps, to call attention to the fact that these have been the two most serious stumbling blocks in all previous operations for prostatectomy. They are simply re-appearing here in another form, chiefly in the hands of the inexperienced.

The occurrence of these accidents does, however, call attention sharply to the necessity of graduate training even for those who are already expert in the field of urology. It proves beyond a doubt that these operations can be satisfactorily done only by experts, and should be attempted by no others.

It is unfortunate that the success of this operation in capable hands has led to the unwarranted assumption that it can be satisfactorily carried out by surgeons familiar with cystoscopic manipulations, or even by physicians with no such experience. Obviously, all of the knowledge and experience which have proved essential to successful prostatectomy by other methods are required here. Mere technical dexterity in transurethral instrumentation will not insure against the complications referred to, nor will they avoid the danger of operating upon the patient in sufficiently prepared. It is, I think, safe to assert that the success of this operation will depend upon a sound training in the surgery of the bladder, upon supervised training in the technique of the methods of operation and on a sufficiently large experience to enable the operator to become thoroughly familiar with the technique. Obviously the operation can be satisfactorily done only by qualified experts. Its performance by those of lesser qualifications will lead, as during the last year, straight to disaster.

HUGH CABOT

CROSS GRAFTING OF ENDOCRINE TISSUES

FAR in the unrecorded past, mankind held the belief that by absorbing into his own body certain tissues of other animals he could acquire the qualities that he attributed to those tissues. The savage ate the heart of the lion to gain the lion's courage. Surgeons have many times attempted to fol-

low the same idea in a less naive manner, seeking to graft the tissues of one individual into the body of another. A limited success has followed some of these experiments. When the grafted material has been used for structural replacements—as for instance to repair defects of bone or tendon—it has many times served a useful purpose. The belief is, however, that not the living cells of the graft survive but merely their non-living scaffolding like the calcium frame work of bone or the collagenous fabric of tendon or fascia. Into this the living cells of the host penetrate and either incorporate it or slowly replace it.

But when it comes to an actual maintenance of living growing, and functioning cells in the body of another animal success has been very rare. Yet, could such transplantations be accomplished they would offer a therapeutic method of great possibilities. There are numerous disorders in which not a structural but a chemical deficiency is present, as best exemplified by lesions that have destroyed essential endocrine glands. Here the replacement of the lost tissue by living cells from another healthy gland would correct the condition. There have been isolated reports of occasional success in such grafts but the great majority of attempts have failed. The writer and his associates have been working for several years in order to develop a method for such cross grafts and at the present time have reached at least a measure of success. The details of this work are reported elsewhere. Certain principles have emerged in the course of this study.

The location in which the graft is placed is important. It should be close to a good blood supply but not in tissue with a dense capillary network, as in such tissue hematoma interferes with the success of the graft. The tissue should be loose without a dense enclosing sheath or capsule that would inhibit the growth of the graft by pressure. The location should

be easily accessible and of course should not be a structure important to life. The axilla and the groin meet these requirements.

The size and form of the graft are important. The cells must live by osmosis and diffusion during the interval between their implantation and the development of an organized blood supply from the vessels of the host. Experience has shown that only a few layers of cells on the periphery of the graft can be so sustained and the central areas undergo necrosis. Hence numerous, very tiny fragments of tissue, or better still the spread out sheets of cells in tissue cultures of the graft afford the best physical form for survival.

The adaptation of the graft to the specific chemistry of the host animal is important. Clinical experiments in grafting skin from one human being to another have frequently looked most promising for a period of 10 days to 2 weeks but rarely have been permanent. They begin to disintegrate after the first apparent take and usually are completely gone in 3 to 4 weeks. This and other such failures have been regarded as evidence that the graft could not thrive in the alien chemical environment of its new host. In the effort to meet this difficulty we have grown the fragments of endocrine glands to be grafted in tissue culture on a medium containing the serum and plasma of the future host. A period of 2 to 4 weeks of such preparatory tissue culture has been employed.

It is probably necessary for the success of a graft that the animal receiving it be deficient in that particular type of tissue. This is the so called Halsted law of deficiency. Whether or not this is universally true we cannot say but it is true that in all of our experimental animals there has been created a deficiency before the grafting and all our human cases were presumably deficient also. The quality of the tissue grafted is important. There is apparently a difference in the vitality and

growth potential of tissue obtained from young animals as compared with old. A parallel factor concerns the age and general health of the host animal. Likely the chances of success are greater when the recipient is young and healthy except for the specific glandular deficiency for which the grafting is performed. Numerous other elements entirely unknown to us enter into the success or failure of cross grafting.

As a result of the application of the principles just outlined a promising measure of success in cross grafting of parathyroid and thyroid tissue has been attained. In a series of dogs about 45 per cent of definitely successful grafts of thyroid tissue was finally attained after many earlier failures. No grafts were considered successful when less than 4 weeks old and some of these grafts were removed as late as about a half year after implantation and found vigorously healthy and apparently growing. The same method has been applied to human patients deficient in thyroid and parathyroid tissue. Most of these cases are too recent to permit conclusions, but two cases, at least, now over a year since grafting, seem to be successful. In estimating the value of any grafting method it must be borne in mind that even in the simplest form of transplantation of tissue, namely the moving of skin from one part of the same individual to another part there is not an infallible 100 per cent of takes. With the additional complication and difficulty of cross grafting it is scarcely rational to expect that any method may be evolved that will not be marred by a certain number of failures. It would obviously be a mistake therefore to expect too much from the work herein discussed but it is equally obvious that some of the interesting problems concerned in cross grafting are repaying investigation. The great clinical and biological interest of the subject surely justifies further study.

HARVEY B. STONE



ROBERT G. LECONTE
1865-1924

MASTER SURGEONS OF AMERICA

ROBERT G. LECONTE

ROBERT G. LECONTE was one of the best known and most highly respected American surgeons in character and ability sustaining the reputation of Philadelphia surgery. Dr. LeConte was born in Long Branch, New Jersey, in 1865; he died in Philadelphia August 3, 1924. The LeConte family were French Huguenots. His father, Dr. John L. LeConte, was a well known entomologist and a distinguished member of the Academy of Natural Sciences of Philadelphia. As a child, LeConte was sent to school in Switzerland where he acquired an excellent facility in the French language which proved of great use to him in his subsequent career. In fact, on his return to America, he spoke French much better than he did English. He received his degree in Arts and in Medicine from the University of Pennsylvania, graduating in the medical class of 1888. During his undergraduate days he was an office student of the late Dr. W. W. Keen. He served his internship at the Pennsylvania Hospital and throughout his career, was continuously on the staff of that institution, being made attending surgeon on the death of John Ashhurst, a position which he held up to the time of his death. For many years he was also surgeon of the Children's Hospital. Later he served as trustee of the University of Pennsylvania, of the Wistar Institute, of the Drexel Institute, and was on the Board of Managers of the Zoological Society.

In the surgical world, LeConte was generally identified with the Pennsylvania Hospital because it was here that his most distinguished surgical work was done. He succeeded Dudley Allen as secretary of the American Surgical Association, he held the position for 8 years and was made president in 1915. He was one of the original group of the Society of Clinical Surgery. In neither of these organizations was there a more popular and beloved member than Bob LeConte.

As an operator, he was both careful and skillful and his patients and all who worked with him were devoted to him. He was always cheerful, optimistic, and encouraging. His two outstanding characteristics were his kindness and charity. New acquaintances soon became admiring and devoted friends.

His social charm put him much in demand and for many years he was the most popular bachelor in Philadelphia. He was a member of all the elite social organizations in and about Philadelphia and was a connoisseur of both food and drink. He also took an interest in all sports, but was never himself athletic. He



University of Cincinnati College of Medicine

enterprise is doomed to failure; advancement in literature, art, ethics, and science are usually neglected by persons devoid of taste, imagination and vision, thus through the ages has knowledge been retarded by scholastic pedant, and heretic.

Dr Bohrer was charged during the first course of lectures with being an intruder who was inciting discord in the faculty and with having a covetous eye on the chair occupied by Drake in the faculty. Visually, if you may, the dramatic scene at the close of the first college year Drake sitting as president listening to the reading of damning politically conceived charges against him, containing recommendations for his expulsion from the faculty and on putting the question to hear a unanimous concurrence in the cabal to deprive him of all further voice in, or connection with, the destiny of the child of his fondest dreams. This repugnant act divided the thriving frontier community into two hostile camps, some of the generous endowments were withdrawn, the subject was vehemently discussed in counting house, social gathering and home. Drake, however, possessed that rare disposition which enables men to be serene in adversity and cheerful in solitude.

Thus began what has been aptly named by an historian as the "Thirty year war," a war which was destined to continue throughout many a weary year to the detriment of college and community.

This bad state of affairs in the faculty was communicated to the State Legislature, with much animosity by friends of Drake. Recognizing the chief defect as being within the faculty board of trustees, the assembly appointed a new board consisting of a non-faculty personnel, but the dis-

sensions, bickerings, and pettifoggery had cast an evil shadow athwart the temple of learning which redounded to the advantage of Transylvania, the only other medical college west of the Alleghenies.

Conditions improved under the aegis of the new board, but were far from being satisfactory. A questionnaire sent by the trustees to the public with a view of determining reasons for failure to advance brought the following significant response: "Dissension of individuals composing the faculty at different times and the want of scientific reputation in the teachers."

How different are the *mores* of the sons of Lyncurus; they will *fight* furiously as long as they are paid, but when the court hands down a decision lawyers lock arms, repair to a liquid joy dispensing emporium and proceed pleasantly to pour a few libations upon the altar and fanes of friendship. Verily it may be said of doctors what Macaulay said of the Stuarts: "They learn nothing they forget nothing." Thus the Ohio Medical College continued to muddle through until the year 1835 at which time a complete reorganization was effected. Drake was offered a chair in the new faculty but he did not accept.

The college continued to function with varying degrees of success, perhaps almost keeping abreast with mediocrity attracting students from widely separated places.

Some outstanding men and others, by contrast, mere mental weaklings, filled or occupied the various chairs and students possessing mere rudiments of education filled the benches. Results of the 2 years' course of lectures were in some instances astounding; men graduated with high

ideals, fond hopes, and considerable learning, who were destined to carry the name of the Ohio Medical College to remote parts of the globe, doctors who later in life became highly proficient as teachers, practitioners, investigators, authors in medicine, art, and literature.

After his expulsion by the faculty trustees in 1820, Drake taught successively at Transylvania, Louisville, and Jefferson Colleges.

While the "Thirty year war" raged with unabated fury Drake was engaged in another war whose objective was to destroy ignorance and open the door of knowledge. In this conquest he traveled extensively on horseback and on foot, by boat and by canoe, covering practically all of the territory lying between the Alleghany and Blue Ridge mountains and the snow-capped peaks of the Rockies, from the Great Lakes to New Orleans. In his travels, Drake frequently slept with the Indians, his rest was disturbed by weird noise of forest and lagoon, his way lay through uncharted woods beset by cries of wild beasts and the war whoops of hostile Indians. Add to such *consequences* of travel the rigors of winter, the heat of summer, and you will have had an incomplete picture of the hardships which this intrepid student encountered.

In these laborious journeys he collected material for his monumental work, "Diseases of the Interior Valley of America," a mere mention of the various topics of which would require all of the space allotted to this thumb sketch of the Ohio Medical College. In recognition of this great work the University of Edinburgh conferred on him the honorary degree of philosophy.

Drake promulgated a plan to connect Cincinnati by canal with the Great Lakes and by rail with the South. He lived to see the former accomplished and the Southern railway was built by the city a few years after his death. The commercial and social value of these improvements to the life and progress of Cincinnati are indisputable and incalculable.

He wrote knowingly extensively on many topics: disease, geology, climate, astronomy, farming, forestation, rain fall, and numerous other themes. He was a walking compendium of useful information, exemplary in his habits, always the student, a man whose life and works are worthy of emulation by those who aspire to success in the realm of art, literature, medicine, or life itself.

In 1849 the Ohio Medical College was in a state of mental apathy and physical decay. Drake now recognized as one of the foremost men of the time, was believed to be the only hope for the future of the institution and an appeal was made to him by

profession and public, to join the faculty. He accepted and began a course of lectures in November 1849. He was received by the students with that acclaim which stimulates the mental faculties of a lecturer to put forth his best efforts to transmit ways and means for obtaining knowledge by his classes. The splendor of simplicity and elegance of diction which marked his opening address to the students are characteristic of the man he was, in this he told without rancor or animosity of his continual solicitation for the welfare of the college and his undying devotion to the child of his creation. He continued to lecture at the college until pneumonia ended his earthly career on November 6, 1852.

Two years before his death he refused to accept the presidency of the American Medical Association, saying he was not worthy of such honor.

Practically illiterate at the age of 15, Drake faced the world with a firm resolution to acquire an education. How well he achieved his objective is attested not alone by his scientific attainments but likewise by his ability to read the classics in the original and deliver lectures in Latin. He was a living example of what Buffon had in mind when he said "Genius is unflagging patience."

He had a keen perception for his surroundings, possessed in unusual degree the powers of deduction and retention, and was interested in all things pertaining to mankind. He was born at Plainfield, New Jersey, of untutored parents October 20, 1785. His voice is silent but the memory lingers and shall linger to challenge comparison with any American doctor so long as the written word shall record the passing of time.

In the year 1896, just 77 years after Drake founded the Ohio Medical College, the institution became, by legislative enactment, the College of Medicine of the University of Cincinnati, a municipally built, owned, and operated university, consisting of nine major colleges with a competent corps of teachers. The Kettering Laboratory, Holmes Hospital and The Cincinnati General Hospital afforded students ample opportunity for experimentation and clinical observation.

The University has an imposing group of buildings located in a beautiful campus surrounded by virgin forest, 12,000 to 13,000 students attend annually.

What lively sensations of delight would surge through the imaginative brain of him who conceived the plan, if his eyes could behold the present picture, a picture which in his vision he saw and with his pen described, now brought to full fruition by a worthy successor, Dr. Christian R. Holmes.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

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PROGRAM FOR THE 1934 CLINICAL CONGRESS IN BOSTON

CLINICAL CONGRESS PROGRAM IN BRIEF

Monday October 15

- 9 30. Hospital conference—Copley-Plaza Ballroom
- 1 00. Clinics in hospitals
- 1 00. Hospital conference—Copley Plaza Ballroom
- 1 00. Surgical film exhibition—Georgian Room, Statler
- 8 3. Presidential meeting—Symphony Hall

Tuesday October 16

- 9 00. Clinics in hospitals
- 9 30. Hospital conference—Copley Plaza Ballroom
- 10 00. Surgical film exhibition—Georgian Room, Statler
- 1 00. Clinics in hospitals
- 1 00. Hospital conference—Massachusetts General Hospital
- 1 00. Surgical film exhibition—Georgian Room, Statler
- 1 00. Section on ophthalmology—John Hancock Hall
- 1 30. Fracture conference—Copley Plaza Ballroom
- 4 00. Ether Day Celebration—Massachusetts General Hospital
- 5 00. Pathological conference—Georgian Room, Statler
- 8 00. Hospital conference—Georgian Room, Statler
- 8 15. Scientific session—Copley Plaza Ballroom

Wednesday October 17

- 9 00. Clinics in hospitals
- 9 30. Hospital conference—Copley Plaza Ballroom
- 10 00. Surgical film exhibition—Georgian Room, Statler
- 1 00. Clinics in hospitals
- 1 00. Symposium: Cancer is Curable—Copley Plaza Ballroom
- 1 00. Section on otolaryngology—John Hancock Hall
- 1 00. Surgical film exhibition—Georgian Room, Statler
- 1 30. Hospital conferences—Boston Lying In and St Elizabeth's Hospitals
- 5 00. Pathological conference—Georgian Room, Statler
- 8 00. Community health meeting—Boston Arena
- 8 15. Scientific session—Copley Plaza Ballroom

Thursday October 18

- 9 00. Clinics in hospitals
- 9 30. Hospital conference—Copley Plaza Ballroom
- 10 00. Surgical film exhibition—Georgian Room, Statler
- 11 30. State and provincial executive committees—Georgian Room, Statler
- 1 30. Annual meeting—Copley Plaza Ballroom
- 1 30. Clinics in hospitals
- 1 00. Section on ophthalmology—John Hancock Hall
- 1 30. Hospital conference—Beth Israel Hospital

- 5 30. Symposium: Diseases of the Esophagus—Copley Plaza Ballroom
- 4 00. Pathological conference—Georgian Room, Statler
- 8 15. Scientific session—Copley Plaza Ballroom

Friday October 19

- 9 00. Clinics in hospitals
- 10 00. Surgical film exhibition—Georgian Room, Statler
- 11 00. Meeting of new Fellows, class of 1934—Copley Plaza Ballroom
- 1 00. Clinics in hospitals
- 1 00. Surgical film exhibition—Georgian Room, Statler
- 1 00. Conference on industrial medicine and traumatic surgery—Copley Plaza Ballroom
- 1 00. Section on otolaryngology—John Hancock Hall
- 1 00. Pathological conference—Georgian Room, Statler
- 8 3. Convocation—Symphony Hall

FOR the twenty fourth annual Congress of the American College of Surgeons to be held in Boston, October 15-19, the surgeons of that great medical center have organized under the leadership of a strong and representative committee and have prepared a program of clinics and demonstrations that will provide a complete showing of their clinical activities in all departments of surgery. The Committee has been assured of the hearty co-operation of the clinicians at the medical schools and more than thirty hospitals that will participate in the program. The clinical program as prepared by the Committee is presented in the following pages.

It will be noted that operative clinics and demonstrations in the hospitals are scheduled for the afternoon of Monday, October 15, beginning at 2 o'clock, and for the mornings and afternoons of each of the following four days. The schedules here published are to be further revised and amplified during the weeks preceding the Congress. The real program will be published daily during the Congress—a complete and accurately detailed program—to be posted in the form of bulletins at headquarters each afternoon for the

succeeding day. The same material will be issued in printed form the following morning.

Special features of the clinical program include (1) Cancer clinics demonstrating the treatment of cancer by surgery, radium and the X ray, (2) fracture clinics at which modern methods in the treatment of fractures will be demonstrated (3) clinics in traumatic surgery for the presentation of methods used in the rehabilitation of injured patients by surgery and physiotherapy.

EVENING MEETINGS

Programs for the five evening sessions, as prepared by the Central Executive Committee, are presented in the following pages. At the pre-dential meeting on Monday evening in Symphony Hall, the president-elect, Dr Robert B. Greenough, of Boston will deliver his inaugural address. A feature of this session will be the John B. Murphy oration in surgery by Dr Donald C. Balfour, of Rochester, Minn.

A number of distinguished surgeons from abroad who will be in attendance at the Clinical Congress will be introduced at this session. Among the visiting surgeons will be the following: Dr Bethel Solomons, Dublin, Ireland; Sir Harold Gillies, Mr A. Lawrence Abel and Mr F. J. Browne, London, England; Mr Harry Platt, Manchester, England; Dr Alexander MacLennan, Glasgow, Scotland; Dr Rafael Silva, Mexico City, Mexico; Prof Josef Halban, Vienna, Austria; Dr Hans Widenhorn, Freiburg, Germany.

On Tuesday, Wednesday and Thursday evenings the scientific sessions will be held in the ballroom of the Copley Plaza Hotel at which eminent surgeons of the United States and Canada together with visiting surgeons from foreign countries will present and discuss papers on surgical subjects of timely importance.

The annual Convocation of the College will be held in Symphony Hall on Friday evening on which occasion the 1934 class of candidates will be received into Fellowship in the College. The president, Dr Robert B. Greenough of Boston will speak on 'Special Cancer Clinics,' and the Fellowship address will be delivered by Dr Lotus D. Coffman, president of the University of Minnesota.

SYMPOSIUM: CANCER IS CURABLE

Further reports by clinicians from various parts of the United States and Canada, presenting additional statistics on the cure of cancer in addition to reports presented at the 1932 and 1933 sessions of the Clinical Congress, will be included in a symposium on cancer to be presented under

the auspices of the Committee on the Treatment of Malignant Diseases in the ballroom of the Copley Plaza Hotel on Wednesday afternoon.

CHARLES A. DUKES, M.D., Oakland, Calif., presiding.
General Subject of Curability of Cancer: FRANKLIN H. MARTIN, M.D., Director-General.
General Cases of Five Year Cures: ROBERT S. CATHCART, M.D., Charleston, S. C.; ROY D. McCLOY, M.D. and ARTHUR MCGRAW, M.D., Detroit; MONT R. REED, M.D. and WILLIAM MILLAR, M.D., Cincinnati; HARRY C. SALZSTEIN, M.D., Detroit; THOMAS A. SHAWLOW, M.D., Philadelphia; FRANCIS CARTER WOOD, M.D., and BENJAMIN RICE SHORE, M.D., New York; A. C. SCOTT, M.D., Temple, Texas.
Cancer of the Stomach and Intestines: WILLIAM T. COUGHLIN, M.D., St. Louis.
Cancer of the Pelvic Organs and Breast: FREDERICK C. HOLDEN, M.D., New York; C. JEFF MILLER, M.D., New Orleans.
Cancer of the Breast: HUBERT A. ROYSTER, M.D., Raleigh; N. C.; HUGH H. THOUT, M.D., Roanoke, Va.
Cancer of the Pelvic Organs: FREDERICK J. TAUBBS, M.D., St. Louis.
Cancer of the Genito-Urinary Organs: EDWIN BEER, M.D., New York.
Cancer of the Rectum: A. LAWRENCE ABEL, F.R.C.S., London, England.
Cancer of the Mouth and Larynx: GORDON B. NEW, M.D., Rochester, Minn.
Lymphatic Tumors: LLOYD F. CRAVER, M.D., New York.

Following these reports a group of papers descriptive of accepted methods for the treatment of cancer will be presented as follows:

Cancer of the Stomach Treated by Surgery: J. SHELTON HOSLEY, M.D., Richmond, Va.
Cancer of the Cervix Treated by Surgery and Irradiation: GEORGE GRAY WARD, M.D., New York.
Cancer of the Breast Treated by Surgery and Irradiation: STUART W. HARRINGTON, M.D., Rochester, Minn.
Cancer of the Lip Treated by Surgery and Irradiation: ELLIS FISCHEL, M.D., St. Louis.
Cancer of the Bladder Treated by Surgery and Irradiation: WILLIAM E. LOWER, M.D., Cleveland.

TRACTION CONFERENCE

A conference on fractures, under the auspices of the College Committee on the Treatment of Fractures, will be held in the ballroom of the Copley Plaza Hotel on Tuesday afternoon.

Among the papers to be presented are:

One Thousand Consecutive Fractures of Both Bones of the Leg: WILLIAM SEWGER, M.D., in collaboration with J. SIDES NORMAN, M.D., Pueblo, Colo.
Operative Treatment of Fractures of Long Bones: HANS WIDENHORN, M.D., Freiburg, Germany.
Treatment of Fracture of the Carpal Scaphoid: D. W. GORDON MURRAY, M.D., Toronto.
Fractures of the Jaw: ROBERT H. IVY, M.D., Philadelphia.
Acute Fractures: MELVIN S. HENDERSON, M.D., Rochester.
Colles' Fracture: HARRY PLATT, M.S., F.R.C.S., Manchester, England.
Further Observations of the Nicola Operation for Recurrent Dislocation of the Shoulder: THOMAS NICOLA, M.D., New York.

Also under the auspices of the same Committee using manikins, splints, tables, and other necessary equipment, hundreds of fractures will be practically demonstrated daily as a part of the scientific exhibition at the Statler Hotel.

CONFERENCE ON INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY

During the past four years the College has conducted investigations and surveys in many parts of the United States to ascertain present medical conditions in industry and to inform employers of adequate methods. The results of these surveys will be presented in the symposium to be held in the ballroom of the Copley Plaza Hotel on Friday afternoon under the auspices of the Board on Industrial Medicine and Traumatic Surgery. Other papers in the symposium deal with the clinical aspects of injuries occurring in industry and methods of rehabilitation of the injured.

FREDERIC A. BEELEY, M.D., Chairman, Board on Industrial Medicine and Traumatic Surgery, presiding.

The Program of the American College of Surgeons in Industrial Medicine and Traumatic Surgery. **FRANKLIN H. MARTIN, M.D.**, Chicago, Director-General.

A Four Years Survey of Medicine and Surgery in Industry. **M. N. NEWCOMB, M.D.**, Chicago.

The Value of an Organized Medical Service in an Industrial Establishment. **THOMAS L. FRANKSON**, President, Newport News Shipbuilding and Dry Dock Company, Newport News, Va.

Papillomas and Carcinoma of the Bladder Among Dye Workers. **GEORGE H. GORDMAN, M.D.**, Medical Director, E. I. du Pont de Nemours & Company, Wilmington, Del.

Back Injuries. **FREDERICK J. CROFT, M.D.**, Boston.
Head Injuries and Their Treatment. **WALTER E. DAWSON, M.D.**, Baltimore.

Reconstruction Surgery. **SIR HENRY D. GILES, C.D.E.**, F.R.C.S., London.

Infections of the Hand Axis. **B. KAY, M.D.**, Chicago.

COMMUNITY HEALTH MEETING

Following its established custom and in recognition of its obligation to the public to provide authoritative information on modern surgery, better hospitals, and the prevention of disease, a community health meeting will be held on Wednesday evening, October 17, under the auspices of the American College of Surgeons in connection with the Clinical Congress. For this purpose the Boston Arena, which accommodates approximately 10,000 people, has been engaged. A program appropriate for the occasion has been prepared consisting of brief interesting talks on scientific medicine, health, and hospitals. These talks will be supplemented by an interesting new sound motion picture on modern hospital care.

ROBERT B. CHANDLER, M.D., Boston, President, American College of Surgeons, presiding.

Address of Welcome. **ARTHUR W. ALLEN, M.D.**, Boston.
The American College of Surgeons—Its Aims and Objects. **FRANKLIN H. MARTIN, M.D.**, Chicago.
A Century of Progress in Medicine. **ALLEN B. KAMAROFF, M.D.**, Chicago.

The Role of Experimental Medicine in Human Surgery. **GEORGE W. CHASE, M.D.**, Cleveland.

Material Care in Approved Hospitals. **MALCOLM T. MACLEACH, M.D.**, Chicago.

Cancer—Its Prevention and Control. **CLARENCE COOK, M.D.**, New York.

Cancer—Its Curability. **CHARLES A. DUKES, M.D.**, Oakland, Calif.

The Care of the Injured. **FREDERIC A. BEELEY, M.D.**, Waukegan, Ill.

The Ache in Your Back. **PHILIP H. KRECHMER, M.D.**, Chicago.

Doctors, Hospitals, and Patients. **ROBERT JOLLY HENSON, Texas.**

Motion Pictures—"Good Hospital Care."

OPHTHALMOLOGY AND OTOLARYNGOLOGY

The committee in charge of the section on surgery of the eye, ear, nose, and throat has arranged a program of ophthalmological and otolaryngological clinics and demonstrations at the hospitals and medical schools. This appears in the following pages, and in addition programs for sessions on Tuesday, Wednesday, Thursday, and Friday afternoons in John Hancock Hall, located on St. James Avenue midway between the Statler and Copley Plaza Hotels. At these sessions distinguished specialists will present papers on subjects of timely interest.

A symposium on "Diseases of the Esophagus" will be presented on Thursday afternoon at 3:30 in the ballroom of the Copley Plaza Hotel following the annual meeting. The program follows:

An X-ray Study on Lesions of the Esophagus (statistical study with lantern slides). **A. B. MACFARLANE.**

Infection of the Esophagus in Acute and Chronic Disease. Phlegmon of the Terminal Portion of the Esophagus (Carcinoma). Etiology and Treatment. **HAROLD P. BLOOMER.**

The Surgical Approach to the Esophagus. **EDWARD D. CARROLL.**

ANNUAL MEETING

The annual meeting of the College will convene in the ballroom of the Copley Plaza Hotel at 1:30 o'clock Thursday afternoon. Reports on the activities of the College will be presented by the officers and chairmen of the standing committees, followed by the election of officers.

MEETING OF NEW FELLOWS

Candidates for Fellowship in the American College of Surgeons, class of 1934, will assemble in the grand ballroom of the Copley Plaza Hotel at 11 a.m. on Friday for the necessary instructions previous to receiving their Fellowships.

PATHOLOGICAL CONFERENCES

The Committee has arranged for a series of pathological conferences to be held in the Georgian Room at the Statler Hotel on Tuesday, Wednesday, Thursday and Friday afternoons from 5 to 6 o'clock, when selected gross specimens from operations performed that day at various hospitals will be demonstrated, accompanied by brief discussions of the lesions involved. In certain cases immediate frozen sections will be demonstrated to correlate the gross and microscopic pathology. Prepared fresh pathological specimens will be on display daily in refrigerated cases in an adjoining room. The demonstrations will be conducted by a group of pathologists from Boston hospitals under the direction of Dr. Shields Warren, as follows:

Tuesday—S. BURT WOLBACH and G. KENNETH MALLORY
 Wednesday—TRACY B. MALLORY and TIMOTHY LEARY
 Thursday—CHARLES F. BRANCH and H. E. MACMILLAN
 Friday—SIDNEY PARKER and J. STEWART ROONEY

SURGICAL FILM EXHIBITIONS

Throughout the week surgical motion picture films, both sound and silent, will be exhibited daily in the Georgian Room of the Statler Hotel. This showing of films demonstrating clinical features of interest has met with popular acceptance in previous years. Many new films are to be shown. Detailed programs will appear in the Daily Bulletin.

A motion picture depicting approved methods of transportation of fracture cases is to be shown daily in the dome room at the Massachusetts General Hospital.

STATE AND PROVINCIAL COMMITTEES

A meeting of the State and Provincial Executive Committees with officers of the College has been called for 11:30 o'clock Thursday morning in the Georgian Room of the Statler Hotel. This meeting is called for the purpose of obtaining information on which may be based the itinerary of the College for its sectional meetings and the desirable grouping of the states and provinces.

ETHER DAY CELEBRATION

Ether Day will be celebrated at the Massachusetts General Hospital on Tuesday with special exercises at 4 p.m. in the auditorium of the Moseley building of the hospital where ether was first administered for the production of surgical anesthesia on October 16, 1846. The motion picture entitled 'The First Public Demonstration of Surgical Anesthesia' will be shown daily in the dome room.

ANNUAL HOSPITAL CONFERENCE

A highly practical and instructive four-day program has been prepared for the seventeenth annual hospital standardization conference during the Clinical Congress in Boston. The program appears in the following pages. Administrative, economic and educational topics will be presented by leaders in the hospital field including surgeons, trustees, administrators, nurses and research workers. These addresses will be supplemented by round table conferences and demonstrations in four of Boston's leading hospitals on Tuesday, Wednesday and Thursday afternoons.

At the opening session on Monday morning distinguished leaders in medical and hospital work will address the conference, the topics to be discussed tending to focus attention on present day problems related to hospital standardization and administration. Other sessions will be devoted to a discussion of major problems of concern to all hospitals—sterilization of surgical dressings, instruments and supplies, and standards for maternal care. Both subjects are now attracting widespread interest, and it is planned to present at these sessions the latest authentic facts pertaining thereto, expecting that such discussions will lead to a definite understanding as to the best standards to be adopted. At a special session on Tuesday evening in the Georgian Room of the Statler Hotel, a comprehensive analysis of the duties and responsibilities of the hospital trustees will be presented.

During recent years there has been a notable increased interest in hospital matters aroused through economic conditions. The problem of giving the patient the best scientific service possible at the lowest cost has seriously engaged the interest of all groups. Attention will be focused on this problem during the four-day conference. Physicians, trustees, administrators, nurses and others will have an opportunity at this meeting to discuss the many problems of mutual concern.

SCIENTIFIC EXHIBITION

The Committee on Scientific Exhibits has drawn upon the abundant medical resources of Massachusetts to provide a remarkably attractive and instructive exhibit for the benefit of the Fellows. At headquarters and in the medical institutions of Boston there will be presented unusual exhibits on various phases of historical and current events in the practice of surgery and its specialties, dentistry, anatomy, pathology, public health and anesthesia. An exceptional feature will be an exhibition of works of art by Massachusetts physicians.

HEADQUARTERS

The Statler and Copley Plaza Hotels will be utilized as headquarters for the Congress. At the former the grand ballroom and adjoining assembly room together with other large rooms on the mezzanine floor have been reserved for the exclusive use of the Congress for registration and clinic ticket bureaus, bulletin boards technical exhibition, and executive offices. A scientific exhibit, which will be arranged by the local committee, is to be installed in the balcony of the ballroom. At the Copley-Plaza Hotel the grand ballroom will be utilized for evening scientific meetings, hospital conferences, and other large gatherings daily.

TECHNICAL EXHIBITION

The technical exhibition will be located in the ballroom and adjoining assembly room at the Statler Hotel. The registration and clinic ticket desk, together with the information bureau will be located in these rooms in which will also be found the bulletin boards on which the daily clinical programs will be posted each afternoon. The leading manufacturers of surgical instruments, electrosurgical and X-ray apparatus, operating room lights, tables, sterilizers, hospital apparatus and supplies of all kinds, ligatures, dressings, pharmaceuticals, and publishers of books will be represented in this exhibition.

SPECIAL TRAIN TO BOSTON VIA
NEW YORK CENTRAL LINES

For the convenience of those living in the central and western states, who will attend the Boston meeting arrangements have been made with the New York Central Lines to provide a special train leaving Chicago at 10 a. m. on Sunday, October 14th, arriving in Boston at 9 a. m. on Monday. The special train will be equipped with all-steel cars of latest design, including club compartment, observation, sleeping and dining cars. No extra fare will be charged. The train will arrive at Cleveland at 5 55 p. m. making connections there with regular trains over the Big Four from Indianapolis and Cincinnati. Fellows are urged to make their reservations for the special train at the earliest possible date, making application at the office of the assistant general passenger agent of the New York Central Lines, LaSalle Street Station, Chicago.

REDUCED RAILWAY FARES

The railways of the United States and Canada have authorized reduced fares on account of the Boston session of the Clinical Congress so that the

total fare for the round trip will be one and one-third the ordinary first-class one way fare. To take advantage of the reduced rates it is necessary to pay the full one way fare to Boston, procuring from the ticket agent when purchasing ticket, a convention certificate, which certificate is to be presented at headquarters for the signature of the general manager of the Clinical Congress and the visé of a special agent of the railways. Upon presentation of the visé certificate to the ticket agent in Boston not later than October 23 a ticket for the return journey by the same route as traveled to Boston may be purchased at one-third the one-way fare.

In the eastern, central, and southern states and eastern provinces of Canada tickets may be purchased between October 11 and 16 in other sections of the United States and Canada at earlier dates. The return journey must be completed within thirty days from date of sale of ticket to Boston.

The reduction in fares does not apply to Pullman fares nor to extra fares charged for passage on certain trains. Local railroad ticket agents will supply detailed information with regard to dates of sale, routes, etc. Stop-overs may be had within certain limits.

Full fare must be paid from starting point to Boston and it is essential that a "convention certificate" be obtained from the agent when the ticket is purchased. These certificates are to be signed by the general manager of the Clinical Congress and viséd by a special railroad agent at Clinical Congress headquarters on or before October 19. No reduction in railroad fares can be secured except in compliance with the regulations outlined and within the dates specified. It is important to note that the return trip must be made by the same route as used in going to Boston, that the certificate must be viséd at headquarters during the meeting, and return ticket purchased not later than October 23.

In the western and southwestern states, including the Pacific coast states and the western provinces of Canada, the railroads have authorized the sale of round trip tickets to Chicago at very low rates on account of A Century of Progress Exposition, so that persons from the west traveling through Chicago to Boston will find it to their advantage to buy round trip tickets to Chicago at the low rates in effect on account of the Exposition. Under this plan it will be necessary to purchase tickets to Boston from Chicago taking advantage of the "convention certificate" plan outlined above. Ticket agents should be consulted with regard to special rates.

ADVANCE REGISTRATION

The hospitals and medical schools of Boston afford accommodations for a large number of visiting surgeons, but to insure against overcrowding attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore that those surgeons who wish to attend the Clinical Congress in Boston will register in advance by applying to the offices of the College at 40 East Erie Street, Chicago.

Admittance to all clinics and demonstrations will be controlled by means of special clinic tickets which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card, which is non transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

BOSTON HOTELS AND RATES

Boston hotels will provide ample facilities and there should be no difficulty in securing first-class accommodations. It is advisable, however for those who expect to attend the Clinical Congress to reserve their accommodations as far in advance as possible. In addition to the headquarters hotels, the Statler and Copley Plaza, there are a number of first-class hotels within walking distance of headquarters. The following list of hotels with their rates has been prepared by the local committee

	Minimum Rates with Bath	
	Single	Double
Bellevue, 21 Beacon Street	\$3 00	\$5 00
Bradford, 275 Tremont Street	2 50	3 50
Brumore, 464 Commonwealth Avenue	3 00	4 00
Brunswick, 300 Boylston Street	2 50	4 00
Buckminster, 645 Beacon Street	2 00	3 50
Canterbury, 14 Charlestown West	2 50	3 00
Charlestown, 535 Beacon Street		4 00
Copley Plaza, 128 St. James Avenue	4 00	6 00
Fensgate, 534 Beacon Street	2 50	3 50
Graylyn, 20 Charlestown West		5 00
Hemenway, 91 Westland Avenue	2 50	3 50
Kennett, 490 Commonwealth Avenue	3 00	4 50
Lenox, Exeter Street	2 50	3 50
Lincolnsquare, 20 Charles Street	3 00	4 50
Manger, North Station	2 50	3 50
Parker House, 60 School Street	3 00	4 50
Puritan, 300 Commonwealth Avenue	3 50	5 00
Ritz-Carlton, 15 Arlington Street	4 00	7 00
Sheraton, 91 Bay State Road	3 00	4 00
Somerset, 400 Commonwealth Avenue	3 00	3 50
Statler Park Square	3 50	5 00
Touraine, 62 Boylston Street	3 00	5 00
Vendome, 160 Commonwealth Avenue	2 50	4 00
Victoria, 271 Dartmouth Street	3 00	5 00
Westminster, 124 St. James Avenue	2 50	3 50

SCIENTIFIC EXHIBITS

AT HEADQUARTERS STATLER HOTEL

FRACTURES Demonstrating methods of treating fractures, under the auspices of the New England Fracture Committee of the American College of Surgeons.

PLASTIC SURGERY An exhibit of models, photographs, and diagrams, illustrating the different methods employed in plastic surgery and the results.

TRAUMATIC SURGERY Diagrams, photographs, and charts.

ORTHOPEDIC SURGERY An exhibit of splints and other forms of orthopedic apparatus, together with charts and photographs.

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH An exhibit illustrating the activities of this department.

CANCER An exhibit from the Palmer Memorial Hospital, Collis P. Huntington Memorial Hospital, and the Providence State Cancer Hospital. Lantern slides, charts, and photographs illustrating cancer of the various organs of the body, the diagnosis and the results obtained by different forms of treatment. Also, an exhibit of specimens of cancer from many parts of the body.

OPHTHALMOLOGY Charts and photographs illustrating melanotic sarcoma and other conditions of the eye. Heredity of various retinal hereditary blindnesses and cataracts.

PATHOLOGY The specimens removed at operations from the various hospitals in the morning will be collected and placed on exhibition in artificially cooled show cases in the afternoon, in a room adjoining the Geor-

gan Room. At 5 p.m. these specimens will be demonstrated in the Georgian Room by a projector, the microscopic sections shown, and the cases discussed.

AT HOSPITALS AND MEDICAL INSTITUTIONS

HARVARD MEDICAL SCHOOL An exhibit of models, photographs, and diagrams showing the restoration of extensive defects and deformities of the face and jaws by plastic surgery and dental prostheses, including cases of soldiers wounded in the World War.

BOSTON MEDICAL LIBRARY Exhibit of historical books on surgery and anatomy and surgical models. Historical portrait illustrating the development of surgery. Wednesday, October 17, John Ware Hall, 4 p.m., presented by the students of Tufts College Medical School under the direction of Professor B. Spector. Exhibition of works of art by Massachusetts physicians under auspices of the Physicians Art Society.

MASSACHUSETTS GENERAL HOSPITAL Daily at noon, an exhibit in the Ether Dome relative to the first public demonstration of ether anesthesia including a showing of the motion picture "The First Public Demonstration of Ether Anesthesia." Also the motion picture film, Fractures in Transportation.

MASSACHUSETTS CRANIAL NERVE AND EAR INTERNAL ANATOMICAL SPECIMENS AND OROPHARYNGEAL INSTRUMENTS HARVARD MEDICAL SCHOOL, WAYNE MUSEUM. Anatomy anatomical specimens pathology pathological specimens.

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Scientific Exhibits—ROBERT B. GELLMAN, Chairman, CHARLES C. SIMMONS, Secretary.
Harvard Medical School Program—DAVID GREENE, Chairman, MAURICE L. GELLMAN, Secretary.
Publicity—FRANK J. COTTON, Chairman, GORDON MORRISON, Secretary.
Entertainment of Foreign Guests—HOWARD BROWN, Chairman, WILLIAM M. SHERIDAN, Secretary.
Public Meeting—ALEXANDER BROWN, Chairman, DANIEL O'HARA, Secretary.
Clinical Bulletin—FRANK OWEN, Chairman.
Ophthalmology and Otolaryngology—OTONOR L. TERRY, JR., Chairman, LYMAN RICHARDS, Secretary, Otolaryngology, THEODORE L. TERRY, Secretary, Ophthalmology.

PROGRAM FOR EVENING MEETINGS

Presidential Meeting—Monday—October 15 8 15 p.m.

- Address of Welcome ARTHUR W. ALLEN M.D. Boston, Chairman, Committee on Arrangements
 Introduction of Foreign Guests FRANKLIN H. MARTIN M.D., Chicago Director General
 Address of Retiring President The Background of the American Surgeon. WILLIAM D. HAGGARD M.D., Nashville, Tenn.
 Inauguration of Officers
 Inaugural Address Efficient Surgical Service in the Whole Community ROBERT B. GREENOUGH M.D. Boston
 John B. Murphy Oration in Surgery Principles of Gastric Surgery DONALD C. BALFOUR M.D., Rochester Minn.

Tuesday—October 16 8 15 p.m.

- Living Grafts of Thyroid and Parathyroid Glands. HARVEY B. STONE, M.D. Baltimore, with the collaboration of JAMES C. OWINGS M.D., and GEORGE O. GUY M.D. Baltimore
 Endocrine Mechanisms in Certain Functional Gynecological Disorders. EMIL NOVAK, M.D. Baltimore
 Fracture Oration The Unsolved Fracture. KELLOGG SPEED M.D. Chicago
 The Giant Cell Tumor of Bone as a Clinical Entity HARRY PLATT M.S. F.R.C.S. Manchester England

Wednesday—October 17 8 15 p.m.

- Hydrocephalus and Spina Bifida. WILDER PENFIELD M.D. Montreal
 Sterility with Special Reference to Surgical Possibilities. BETHEL SOLOMONS M.D., F.R.C.P.I. Dublin Ireland
 Diverticulosis and Diverticulitis. IRVIN ABELL, M.D., Louisville
 Plastic Surgery SIR HAROLD GILLIES, C.B.E. F.R.C.S. London, England.

Thursday—October 18 8 15 p.m.

Symposium on Treatment of Infections

- Infections of Clean Operative Wounds. FRANK L. MELENEY M.D. New York
 Discussion IRVING J. WALKER, M.D. Boston
 Infections of the Lip and Face. FREDERICK A. COLLIER, M.D. Ann Arbor Mich.
 Discussion ELLIOTT C. CUTLER, M.D. Boston
 Phagedenic Ulcer Its Recognition and Treatment. EMILE HOLMAN M.D., San Francisco
 Discussion EDWARD D. CHURCHILL, M.D. Boston
 The Repairs of Defects Resulting from Full Thickness Loss of Skin from Burns. JAMES B. BROWN, M.D. St. Louis
 Discussion V. H. KAZANJIAN M.D. Boston

Convocation—Friday—October 19 8 15 p.m.

- Invocation. REV. CHARLES WESLEY BURNS D.D. LL.D. Boston
 Presentation of Candidates for Fellowship FRANKLIN H. MARTIN, M.D. Chicago Director General
 Conferring of Fellowships. The President
 Conferring of Honorary Fellowships The President
 Presidential Address Special Cancer Clinics. ROBERT B. GREENOUGH M.D. Boston
 Fellowship Address LOTUS D. COFFMAN Ph.D., LL.D. President University of Minnesota

ANNUAL HOSPITAL STANDARDIZATION CONFERENCE

Monday 9 30-12 30—Ballroom, Copley-Plaza Hotel

Chairman's Address: WILLIAM D. HARGROVE, M.D., Nashville, Tenn.

Presentation of Seventeenth Annual Hospital Standardization Report: FRANKLIN H. MARTIN, M.D., Chicago.
Guiding Fundamental Principles for Preparation of Hospital and Medical Services: CHARLES A. DUKES, M.D., Oakland, Calif.

The Development of Periodic Prepayment Plans for Hospital Care in England: STURGEY LAMBE, Liverpool, England.

The Hospital in Retrospect and Introspect: RAY ALBROW, M.D., SCHUETZ, S.J., Ph.D., St. Louis.

Future Trends in Hospital Management and Service: BENJ. W. CALDWELL, M.D., Chicago.

The Proper Interpretation of Hospital Service: NEWTON E. DAVIS, D.D., Columbus, Ohio.

What the Hospital Can Do for the Younger Surgeon: WITTEN B. RUM, M.D., San Antonio, Texas.

Principles Governing Relation of Radiologists to Hospitals: ARTHUR C. CHRISTIE, M.D., Washington, D.C.

Monday 2 00-5 00—Ballroom, Copley-Plaza Hotel

Standards for Obstetrical Service in Hospitals:

GEORGE W. KOENIG, M.D., New York, presiding.
A Study of Obstetric Complications in the Women's Hospital to Establish Proper Standardization for Statistical Purposes: GEORGE GRAY WARD, M.D., BRIDGEPORT, M.D., and ALBERT H. ALDRIDGE, M.D., New York.

Regulations and Control of Obstetrical Practices in Institutions by Nonstaff Physicians: SAMUEL A. COCKRYE, M.D., Jersey City, N.J.

Minimum Standards of the American College of Surgeons for the Care of Obstetrical Patients in General Hospitals: ROBERT A. JONES, M.D., Houston, Texas.
General discussion led by JAMES RAGLAN MILLER, M.D., Hartford, Conn.

Tuesday 9 30-12 30—Ballroom, Copley-Plaza Hotel

Sterilization of Dressings, Instruments, and Supplies: G. HARVEY AGNEW, M.D., Toronto, Ont., presiding.
Observations on Sterilization of Dressings with Specific Reference to Sterilizing Chamber Temperatures and Their Relation to Sterilizer Chart Temperatures and Cultures: SAMUEL R. D. HENNER, M.D., St. John, N.B.

A Scientific Analysis of Steam in Sterilizing, Showing How Precision Methods May Be Substituted for the Indefinite Methods now in Vogue: WILSON B. URMERSON, Eng., Pa.

The Fundamental Principles Underlying the Mechanics and Technique of Sterilization: HENRY T. WYATT, M.S., Madison, Wis.

Checking and Controlling Postoperative Complications: HAROLD E. FOST, M.D., Danville, Pa.

General discussion opened by CLAUDE W. MICHON, M.D., Valhalla, N.Y.

Tuesday 2 00-4 00—Massachusetts General Hospital

Demonstrations and round table discussions in Hospital Standardization and Administration: Conducted by GEORGE H. BRIGGLOW, M.D., Director and heads of departments.

The Organization of an Anesthesia Service: HOWARD BRADSHAW, M.D., Anesthetist.

Social Problems of the Surgical Patient: IRA M. CANNON, Chief, Social Service Department.

Experience with a Hospital for People of Moderate Means: MORRIS J. KREIER, M.D., Assistant Director.

Eight Hour Nursing: SALLY JOHNSON, R.N., Superintendent of Nurses.

Tuesday 2 00-10 00 p.m.—Georgian Room, Steller Hotel

Special Session for Hospital Trustees

C. P. CURTIS, Boston, presiding.
How I, as a Hospital Trustee, View my Responsibility: IRA M. CANNON, Boston.

How I, as a Hospital Trustee, Discharge my Duties: FRANK BARKER, Bristol, Conn.

How I, as a Trustee, Judge the Efficiency of our Hospital: IRVING L. NEWBORN, Boston.

How the Trustees of the Hospital Can Promote Public Relations: PAUL H. FEELEY, Chicago.

General discussion led by JOSEPH C. DOANE, M.D., Philadelphia.

Motion Picture—Good Hospital Care (sound)

Wednesday 9 30-12 30—Ballroom, Copley-Plaza Hotel

Joint Session with Association of Record Librarians of North America: JAMES T. NIX, M.D., New Orleans, presiding.

The Use of the National Nomenclature: H. B. LOOMIS, M.D., New York.

Basic Training for a Record Librarian: JENNIE N. HANCOCK, Rochester, N.Y.

The Organization and Management of the Medical Record Department in a Eastern Hospital: STANLEY M. PATRICK, O.S.B., B.S., Detroit, Mich.

Round table conference—problems concerned with clinical records with special discussion of use of clinical records. Conducted by ALLAN CHASE, M.D., Torrington, Conn.

Wednesday 2 30-5 00—St. Elizabeth's Hospital

Demonstrations and round table discussions in hospital standardization and administration. Conducted by RAY THOMAS J. BROWN, Superintendent, and heads of departments.

Obstetrical Department in a General Hospital: CHARLES J. KICKHAM, M.D., Obstetrician-in-Chief.

Care of Emergencies: CORNELIUS J. O'LEARY, M.D., Senior Intern.

Out Patient Department—Does the general public take undue advantage of the free clinic? RAY THOMAS J. BROWN, Superintendent.

Securing Autopsies—Why should the hospital try to increase the number of autopsies? FRANK P. MCCARTHY, M.D., Pathologist.

Wednesday 2 30-5 00—Boston Lying In Hospital

Demonstrations and round table discussions in hospital standardization and administration. Conducted by LOUISE S. ZUTTER, Superintendent, and heads of departments.

Pre-natal Clinic: EMMETT CORLEA, R.N., Director of Clinics.

Admission of Patient, Care of Patient in Labor, Delivery Room and Immediate Postpartum Care: MARTHA WALLER, R.N., Supervisor of Delivery and Operating Floor.

Care of Newborn Baby Formula Room A. BERNICE
DeNORON, R.N., First Assistant, Training School
Care of Premature Baby DOROTHY SOLOMON, R.N.
Supervisor of Premature Nursery

Care of Postpartum Patient EDITH CARPENTER,
R.N., Instructor of Nurses

Care of Isolated or Septic Patient. FLORENCE BOS-
TOCK, R.N. Supervisor of Septic Division.

Postpartum Clinic. FLORENCE SWANSON, R.N., Sup-
ervisor of Clinics

Notion picture—Around the Clock with You and Your
Baby

Thursday p 30-12 30—Ballroom Copley-Plaza Hotel
Round table conference. Conducted by ROBERT JULY
Houston, Texas, assisted by MALCOLM T. MACLEACH
New, M.D., Chicago. This will be a clearing house for
all questions arising out of deliberations of previous

sessions and problems in the minds of any present, in
addition to a special program of fifty important
hospital questions

Thursday, 2 30-5 00—Bulb Israel Hospital

Demonstrations and round table discussions in hospital
standardization and administration. Conducted by
CHARLES F. WILKINS, M.D. Director and heads of
departments.

The Training of Internes in the Social Aspects of Ill-
ness. EUGENE COHEN, Director of Social Service.

Food of Hospital Patients. MARIEA MOORE, Dieti-
tician-in-Chief

Nursing Problems in a General Hospital. JOSEPHINE
A. MULVILLE, R.N. Superintendent of Nurses.

Application of Business Principles in the Management
of Hospitals. CHARLES F. WILKINS, M.D., Di-
rector. Deputy Health Commissioner of Boston

OPHTHALMOLOGY AND OTOLARYNGOLOGY—SCIENTIFIC SESSIONS

Tuesday—John Hancock Hall 2—Ophthalmology

HARRY S. GRADLE, Chicago. Recent therapeutic proce-
dures. Discussion opened by ALLEN GREENWOOD

JONAS S. FRIEDENWALD, Baltimore. Silt lamp ophthalmos-
copy. Discussion opened by J. H. WATTS

JOHN M. WHEELER, New York. Plastic ophthalmic sur-
gery. Discussion opened by W. B. LANCASTER

RAFAEL SILVA, Mexico City. Subject to be announced

Wednesday—John Hancock Hall 2—Otolaryngology

THOMAS E. CARROLL, Denver. Congenital deformities of
the face and neck. Discussion opened by V. H.
KAZANJIAN

LOUIS H. CLERT, Philadelphia. Peroral endoscopy in
otolaryngological practice.

SAMUEL J. CROWE, Baltimore. Ménière's symptom com-
plex. Discussion opened by PHILIP MELTZER

JOHN R. PAGE, New York. Acute infections of the middle
ear and mastoid

O. JASON DIXON, Kansas City. A departure in the manage-
ment of acute mastoid disease or the advantages of
conservative treatment in acute mastoid disease.

Discussion opened by LYMAN RICHARDS.

GEORGE M. COATES, Philadelphia. Diagnosis of chronic
infection of the tonsils in relation to indications for
operation in cases of chronic focal infection

WILLIAM V. MULLIN, Cleveland. Present status of infec-
tion of the upper respiratory tract in its relation to
focal infection. Discussion by H. ARTHUR LOE NIKKEN

EDWARD ZIEGLERMAN, San Francisco. The cellular char-
acter of one hundred temporal bones. Clinical and sur-
gical significance. Lantern slides

Thursday—John Hancock Hall 2—Ophthalmology

LOTHAR C. PETTIT, Philadelphia. The technique of orth-
optic training in strabismus. Discussion opened by
LEONARD H. HARDY, New York

CLARENCE KING, Cincinnati. Tuberculin in the treatment
of ocular tuberculosis. Discussion opened by MAX
WILL KINGS

WILLIAM L. BENEDICT, Rochester, Minn. Intravenous
therapy in diseases of the visual tract (salvarsan, gold
sodium thiosulphate). Discussion by ALBERT H.
BROWN, Cincinnati

C. V. SPURR, Minneapolis. Closure of the cataract in-
cision (motion pictures). Discussion opened by F. H.
VERHOEFF

Ballroom, Copley-Plaza Hotel—3 30—Otolaryngology

A. S. MACMILLAN, New York. A study on lesions of the
esophagus (statistical study with lantern slides)

HARRIS P. MOORE, Infection of the esophagus in acute
and chronic disease. Fibrosis of the terminal portion
of the esophagus (cardiospasm), etiology and treat-
ment

EDWARD D. CHURCHILL, The surgical approach to the
esophagus

Friday—John Hancock Hall 2—Otolaryngology

SAMUEL J. KOPETZKY, New York. Recent developments in
the diagnosis of meningitis.

WELLS P. EAGLETON, Newark, N. J. Meningitis—result of
disease of the petrous apex and sphenoidal basis

MARVIN F. JONES, New York. Pathways of approach to
the petrous pyramid. Discussion by HARRY P. CARRILL

WILLIAM ALTMAN, Cincinnati. When and how shall a
nasal sinus inflammation be treated nonsurgically?

EDWARD C. SEWELL, San Francisco. Operative treatment
of sinusitis, external approach. Discussion opened by
CHARLES T. PORTER

GABRIEL TUCKER, Philadelphia. Cancer of the larynx.

HENRY B. ORTON, Newark, N. J. Cancer of the laryngo-
pharynx. Discussion opened by LEROY A. SCHALL

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY GYNECOLOGY, OBSTETRICS ORTHOPEDICS UROLOGY
PROCTOLOGY SURGICAL PATHOLOGY ETC

CHILDREN'S HOSPITAL

Monday

F R OWER and associates—3 Dry clinic Fractures in children A H BARNES Fractures of thigh and leg M KATZOFF Fractures of the arm, elbow and forearm

Tuesday

F R OWER and associates—9 Orthopedic operations
W E LAND—9 30 Plastic repair of harelip and cleft palate, demonstration of cases, motion picture demonstration

THOMAS H LARSEN—10 Acute osteomyelitis in infancy and childhood

PATRICK J MAHONEY—10 30 The use of various types of skin grafts in children's surgery

HENRY HUNTER, JR.—11 Acute appendicitis in childhood Meckel's diverticulum

Staff—3 Operative clinic, surgery in infants and children

Staff—3 Orthopedic clinic A T LEOO Early treatment and the prevention of deformities in poliomyelitis

F R OWER Shoulder operations J W SURYIA Stabilization of the ankle joint A T LEOO Abducting lamp

Wednesday

Staff—9 30 Operative clinic

W E LAND—1 Congenital hypertrophic pyloric stenosis Intussusception, diagnosis and treatment

DONALD W MACCOLLUM—3 30 Treatment of undescended testes, and results over a 34 year period

THOMAS H LARSEN—3 Chronic pulmonary suppuration demonstration of cases

HENRY HUNTER, JR.—3 5 Empyema in childhood, its treatment

SIMONY FARRER—3 30 Surgical pathology of malignant tumors in infancy and childhood, followed by demonstration of pathological specimens in department of pathology

EDW AND C VOOT—3 45 Myeloma in children

Thursday

F R OWER and associates—9 Orthopedic operations

W E LAND—9 30 Intestinal twists, diagnosis and treatment, demonstration of cases, lantern slides

PATRICK J MAHONEY—9 Types of tracheo-oesophageal fistule, differential diagnosis and operative treatment

congenital and acquired oesophageal structure, demonstration of methods of dilatation

W E LAND—10 30 Atresia of the bile ducts, diagnosis and treatment, choledochus cyst, diagnosis and treatment

THOMAS H LARSEN—1 Ureteral transplantation for atresia of the bladder demonstration of treated cases

Staff—3 Operative clinic, surgery in infants and children

Staff—3 Orthopedic dry clinic A H BARNES Claw feet F H MORRIS Torticollis, mastoid approach

H FRIEDMAN Dislocation F R OWER and SIMONY FARRER Semilunar cartilage H FRY

SHOONER Osteoclase R H MORRIS Ligamentous operation for club foot

Friday

Staff—9 Orthopedic clinic S M FITCHER Cleidocranial dysostosis F R OWER Shell operations S M

FITCHER Flexion deformity of the hip A T LEOO Coxa plana F R OWER Sprengel's deformity

R H MORRIS Knee flexion deformity

Staff—9 30 Operative clinic, surgery in infants and children

W E LAND—2 Ulcerative colitis in childhood—diagnosis and treatment demonstration of cases, lantern slide demonstration

TRACT PETERMAN—3 30 A new method of treatment of hydrocephalus by endoscopic electrocoagulation of the choroid plexus

DONALD W MACCOLLUM—3 45 Treatment of hemangioma by endothermy demonstration of cases

W E LAND—3 Surgical significance of pyoma in infancy and childhood, demonstration of cases, lantern slide demonstration

T H LARSEN—3 30 Malignant bladder tumors in childhood

PEABODY HOME

Wednesday

F R OWER and associates—9 Orthopedic clinic

PALMER MEMORIAL HOSPITAL

Tuesday

Staff—9 Treatment of malignant disease, including surgery electrosurgery and radium implantation, operative clinic

Staff—3 Dry clinics G A LELAND Carcinoma of cervix FLETCHER COLBY Urinary tract complications from carcinoma of the cervix L S MCKERRICK

Interstitial radiation for carcinoma of the breast R H DUNSTON Irradiation of the ovary in cancer of the breast GEORGE G SMITH Diversion of the urinary stream JOHN HOSKINS Relief of pain in malignant disease

Staff—3 Dry clinics D F JOHNS Surgical management of carcinoma of the rectum L S MCKERRICK Factors favoring early diagnosis of cancer of the colon, principles of treatment R H SWENY Polypoid of the colon SAMUEL WARRIOR Pathological aspects of rectal polyp WYMAN RICHARDSON Blood dyscrasias after gastrectomy and short-circuiting operations on the intestinal tract

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Staff—9 Treatment of malignant disease including surgery electrosurgery and radium implantation, operative clinic

BEVERLY HOSPITAL

Thursday

PETER JOHNSON and JOHN ADAMS—1 Fracture clinic

BOSTON CITY HOSPITAL

Monday

Staff—3 Dry clinic. J J REGAN S WEISS and D MURRO The eye in arteriosclerosis, hypertension and tumor. G. K. COOKE Treatment of shock. J REYNOLDS and M. RITVO Pellagra Strida's disease, diagnosis and treatment. O J HERMANN and E. PARKER, Jr. Synovitis of knee. F. A. SLOWICK Septic hips

Tuesday

DAVID D. SCARFELL, SONS FRASER, THOMAS W. WICKHAM and JOHN A. SEIN—9 General surgical dry clinic.

First surgical service—9 General surgical operative clinic. HORACE BINKLEY Thoracoplasty for unilateral phthisis, phrenicectomy for unilateral phthisis. JAMES J. HERBURN Repair of ventral hernia gastric ulcer. GEORGE W. PAPER Chronic empyema cholecystitis

Fifth surgical service—3 Dry clinic. IRVING J. WALKER Some surgical aspects of jaundice—hyperparathyroidism, end-results repair of common duct chondrosarcoma of humerus, end-results carcinoma of stomach and result ligation of common carotid artery end-result. FRANCIS F. HENDERSON Carcinoma of lung pancreatitis, review of sixty cases. AUGUSTUS RILEY Prostate and vesicles as foci for retroperitoneal infection kidney resections demonstration of cases. CHARLES C. LUND Peripheral arterial embolism, results of operative treatment in fifteen cases. E. EVERETT O'NEIL Breast tumors, clinical versus X ray diagnosis. WILLIAM A. WHITE Subject to be announced

ROBERT M. GREEN JOHN T. WILLIAMS, FREDERICK L. GOOD, JOSEPH P. COHEN and associates—3 Gynecological and obstetrical dry clinic Treatment of miscarriages puerperal sepsis pelvic inflammation

Wednesday

IRVING J. WALKER FRANCIS F. HENDERSON CHARLES C. LUND E. EVERETT O'NEIL and WILLIAM A. WHITE—9 General surgery operative clinic

Bone and joint service—9 Dry clinic. OTTO J. HERMANN Boston City Hospital bone and joint service. THOMAS H. PETERSON Colles' fracture therapy Souther traction in unreduced fractures of the forearm and old shoulder dislocations. GEORGE K. COOKE Fracture of the olecranon new operative repair. OTTO J. HERMANN Recurrent shoulder dislocations repaired by the Nikola method, end results, discussion. WILLIAM F. COTTING and MARK H. ROGERS Subdeltoid bursitis. ALAN H. ROGERS Rupture of supraspinatus tendon discussion. JOSEPH H. SHORTELL Spinal fracture therapy. RUSSELL F. SULLIVAN Spinal fusions. OTTO J. HERMANN Compound fracture therapy. FRANK W. MARVIN Anesthesia in fractures

First surgical service—3 Dry clinic. NEWTON C. BROWDER Results of treatment of Colles' fracture modern splinting methods in fracture therapy. JAMES J. HERBURN Results in treatment of peptic ulcer giant-cell sarcoma of bone treatment of ventral hernia. HORACE BINKLEY Methods and results in treatment of acute empyema, lung abscess, bronchiectasis, pulmonary tuberculosis. GEORGE W. PAPER Methods and results in treatment of chronic empyema

Sixth surgical service—3 Dry clinic. JAMES W. SEVER Separation of femoral epiphysis. MARK H. ROGERS Ankylosed hips. OTTO J. HERMANN Treatment of intracapsular fractures of neck of femur demonstration of cases of recent fractures and ununited frac-

tures. FREDERICK J. COTTON Pelvic fractures. JOSEPH H. SHORTELL Bone grafting. ROBERT M. GREEN JOHN B. WILLIAMS, FREDERICK L. GOOD JOSEPH P. COHEN and associates—9 Gynecological and obstetrical operations.

Thursday

OTTO J. HERMANN JOSEPH H. SHORTELL, WILLIAM F. COTTING RUSSELL F. SULLIVAN THOMAS H. PETERSON and G. KENNETH COOKE—9 Operative bone and joint clinic. Ward rounds, demonstration of fracture apparatus, etc.

Second surgical service—9. ROBERT C. COCHRANE Total thyroidectomy for congestive failure and angina. Parathyroid tumors. WILLIAM R. MORRISON One hundred perforated ulcers of the stomach and duodenum from the Boston City Hospital, stomach surgery motion picture demonstration demonstration of following cases—total removal of stomach for cancer with anastomosis of the jejunum to the oesophagus, hour-glass deformity of the stomach, cholecystogastrostomy formed by nature. THOMAS K. RICHARDS Knee joint pathology. JOHN J. LUCY Recurrent intussusception caused by intestinal tumor carcinoma of the sigmoid. RICHARD I. SMITH Pancreatitis. HERBERT H. HOWARD End-results of bilateral renal tuberculosis, importance of postoperative treatment of prostatectomized patient.

Fourth surgical service—3 Dry clinic. ARTHUR R. KIMPTON Civilian gas gangrene tetanus use of amniotic liquid concentrate cavernous hemangioma of neck catheter in common bile duct since 1926 ununited fractures. EDWARD HARDING Demonstration of cases. JOSEPH H. BURNETT Colles fracture therapy. H. A. BOUVIE Treatment of acute traumatic abdomen.

Sixth surgical service—3 Bone and joint dry clinic. WILLIAM F. COTTING Gonorrheal arthritis of the knee. RUSSELL F. SULLIVAN Hallux valgus therapy. OTTO J. HERMANN Fractures of the os calcis therapy discussion. JOSEPH H. SHORTELL Bone tumors. FREDERICK W. O'BRIEN Pre and postoperative X ray therapy in malignant tumors of the bone. THOMAS H. PETERSON "Fender" fractures.

ROBERT M. GREEN JOHN B. WILLIAMS, FREDERICK L. GOOD JOSEPH P. COHEN and associates—9 Obstetrical and gynecological operations.

Friday

ARTHUR R. KIMPTON ROBERT C. COCHRANE, WILLIAM R. MORRISON, STEPHEN P. MALLETT and V. H. KAZANJIAN—9 General surgery operative clinic.

Staff—9 Gynecological and obstetrical operations.

Staff—3 Dry clinic. J J REGAN and W B CASTLE The eye in anemic patients. STEPHEN P. MALLETT Fractures of the jaw. WILLIAM R. MORRISON Visualization of arteries and veins for diagnosis and operation of aneurysm ligation of the first part of right subclavian artery and subsequent ligation of innominate artery for arteriovenous aneurysm of internal jugular vein and subclavian artery. OTTO J. HERMANN and WILLIAM R. MORRISON Chronic subluxation of sternal end of clavicle. STEPHEN J. MADDOCK The Baer magnet treatment of chronic osteomyelitis.

Physiotherapy service—9 Dry clinic. JOSEPH REBNICK Electrodiagnosis. JOSEPH REBNICK, GIBBIE W. DICKINSON ARTHUR J. COLE, WALDO W. ROBERTS and SIMEY M. SIMONS Demonstration of cases and treatment

MASSACHUSETTS GENERAL HOSPITAL

Monday

Staff—*a* Dry clinic A W ALLEN Bleeding peptic ulcer
JOHN STEWART Water balance in the surgical patient.
C M JONES Nutritional disorders L S McHARRISON
Cancer of rectum E L YOUNG, Jr Cancer of colon
J V MILES and F W HOYT Rupture of Graafian
follicle and corpus luteum R H WALLACE Treat-
ment of burns

W J MILETS and associates—*a* Symposium on neuro-
surgery W J MILETS Rupture of the intervertebral
disc J S HODGSON Head injuries requiring oper-
ation R G VANCE Healing of skull fractures T J
PURNAM Injection and coagulation of the gas-
tric ganglion H R VINT Significance of free grasp-
ing in localization of brain tumor R H SUTTERICK
Surgery of the splanchnic nerves J S HODGSON
Treatment of pain in malignant diseases W J
MILETS Intracranial approach to the orbit, tight
scaleneus anticus muscle

V H KATHURAN and E M DALAND—*a* Plastic surgery
clinic Partial excision of keloids reconstruction of
the lip after partial or complete removal relief of con-
tractures from burns treatment of λ ray burns treat-
ment of congenital and acquired deformities of the
face and jaw including bun lip and cleft palate,
prognathism of the mandible and temporomandibular
ankylosis treatment of nasal deformities

Staff—*a* Obstetrical dry clinic T R GORTLIER Cancer
of cervix complicating pregnancy M I EAMES
Gas bacillus infection in pregnancy J ROCK Habit-
ual abortion R S TRIM Diabetes and pregnancy

Tuesday

Staff—*a* Operative clinics General surgical, neuro-
surgical, genito-urinary and thyroid services

T W HURDLE H C MARRAS and F G BLUNT, Jr—*a*
Surgery of the hand T W HURDLE Anatomy
ligation of tendons and nerves, burns, Dupuytren's
contracture, tuberculosis, tenosynovitis and bursitis
H C MARRAS Infectious, technique crushing in-
juries, burns, Volkmann's contracture fractures, old
traumatic contractures F G BLUNT, Jr Tumors

GEORGE W HOLLAND and associates—*a* λ -ray symposium
GEORGE W HOLLAND The management of roentgen
scoliosis—particularly its relation to operative pro-
cedures A O HANFORD Benign and malignant
gastric ulcerations R SCITATI The diagnosis of
esophageal cancer W C MARTIN The λ ray find-
ings in acute obstructing lesions of the gastro-intest-
inal tract J SERRA A portable unit for making
very rapid exposures in the examination of post-
operative pulmonary lesions R G VANCE Some
observations on old fractures of the skull J R
LINDGREN The roentgen treatment of malignant
hypertension C G SMITH The combined surgical
and roentgenological treatment of actinomycosis

E D CHURCHILL and associates—*a* Surgical research
laboratories, demonstration of specimens

M N SMITH-PETERSEN and associates—*a* Orthopedic
clinic E I CAVE Tuberculosis of the spine, end
result study M N SMITH-PETERSEN Tuberculosis
of the sacro-thacic joint end-result study J BAER
Tuberculosis of the hip end-result study G VAN
GORDEN Alusion of spinal fusion as an operation for
non-tuberculous conditions W A ROCKES Analysis
of mechanics involved in the treatment of compression
fractures of the spine S ROBERTS Slipped capital
epiphyses of the femur analysis of operative treatment

M N SMITH-PETERSEN Closed reduction of the hip
versus open reduction followed by internal fixation

Wednesday

Staff—*a* Operative clinics, general surgical, neurosurgical,
fracture and circulatory services

Staff—*a* Dry clinic D KING Postoperative pulmonary
complications H BRADSHAW Methods in anesthe-
sia H SPRINGER Surgery in cardiac patients L S
McHARRISON and R H MILETS Ulcerati colitis
L D CHURCHILL Cardiotomy E D BROWDER
Gastroscopy R H MILETS Osteomyelitis A E
FRIEDMAN Hemorrhage in relation to shock from the
standpoint of activity of the sympathetic nervous
system

J V MILES, F ALBRITTON and associates—*a* Ovarian
dysfunction clinic

G A LELAND and associates—*a* Fracture clinic D F
JONES Organization of the fracture clinic G A
LELAND Common complications of the treatment of
simple fractures M N SMITH-PETERSEN Critical
survey of the present treatment of fractures of the
neck of the femur by nailing H ROCKES The use
and value of moving pictures in hospital teaching
G VINGGORDEN Presentation of cases

E F HAYES and associates—*a* Proctology

Thursday

Staff—*a* Operative clinics, general and thoracic surgery

E A COOMAN and associates—*a* Shoulder clinic M R
SMITH-PETERSEN Tendinitis (periarthritis) GROSSER
W HOLLAND λ -ray diagnosis LYON BROWN Posture
in relation to shoulder lesions J H MILES Shoulder
symptoms in internal disease HENRY VINT Hysteria
and allied conditions J B AYER Cord and vertebral
lesions W J MILETS Brachial plexus injuries
FRANK OBER Delirious paralysis HENRY MARRAS
Bassett's operation GROSSER W VAN GONDEL
Nicola's operation PHILIP WILSON Ruptured respira-
tories SPENCER ROBERTS Fractures and disloca-
tions of the head of the humerus JOSEPH ACH
Tortic colliculus WALTER BAKER Arthritis, acromi-
oclavicular and cervical JOHN HODGSON Cervical rib
CHURCHILL SYMPOSIUM Tumors of the shoulder bones
ROY MARRAS Rare conditions in the shoulder T B
ALLEN Pathology of the subacromial bursa M
N SMITH-PETERSEN Excision versus ankylosis of
shoulder G H BIGGLOW Follow-up system at the
Massachusetts General Hospital General discussion

T B MALLORY—*a* Clinical pathological conference

E D CHURCHILL, W WATKINSON and associates—*a*
Thoracic surgery clinic

Staff—*a* Peripheral vascular clinic A W ALLEN Gen-
eral management of peripheral vascular disorders
L S McHARRISON Management of peripheral
arterial lesions in diabetes R H SUTTERICK Neuro-
vascular surgery in thrombo-angitis obliterans and
vasomotor imbalance H H FAYOW Present status
of the conservative treatment of varicose veins R R
LEWIS Peripheral embolism R C PRATT Phle-
bitis and lymphangitis N LINDGREN The patho-
logical physiology of gangrene R S LAMPSON The
effect of tobacco smoking on the rate of peripheral
blood flow J SEARS Lymphedema and lymphan-
gitis J L GUARDO Out-patient treatment of var-
icose veins and ulcers JAMES DAVIDSON Demonstra-
tion of Pavlov apparatus J KELLEN Podiatry in
peripheral vascular lesions

C G SHIMMONS and associates—Tumor clinic cancer
symposium

Friday

- Staff—9. Operative clinics, general surgical and orthopedic services, neurological operations plastic surgery
- Staff—12. Dry clinic. C. LYONS. Symploctic infections. B. VINCENT and A. V. BOCK. Surgery of spleen. A. W. ALLEN. Regional ileitis. R. H. MILLER. Tuberculosis of the lymphatic system. R. LINTON. Perforation of the cecum complicating carcinoma of colon. R. H. SMITHWICK. Gall-bladder disease, correlation of operative and X ray findings. OLIVER COPE. The role of the pituitary and other endocrine glands in carbohydrate metabolism. H. ROOZEK. Pituitary sinus.
- Staff—2. Diseases of the thyroid and parathyroid. J. H. MEARS and J. LERMAN. Medical aspects of the management of exophthalmic goiter. A. W. ALLEN. Surgical aspects of the management of exophthalmic goiter. R. H. MILLER. Nodular goiter. E. L. YOUNG. Intrathoracic goiter. E. D. CHURCHILL and FULLER ALBRIGHT. The parathyroids. S. HENRI. The role of the pituitary in thyroid syndromes.
- J. D. BARNETT and associates—1. Genito-urinary surgery

CARNEY HOSPITAL.

Monday

- HAROLD G. LEE—3. Operative treatment for certain types of low back pain, demonstration of cases.
- R. J. HUFFMAN—3.30. End results following inter position for uterine prolapse.

Tuesday

- LOUIS E. PHANEUF—9.30. Vaginal hysterectomy for proctodentia, repair of third degree laceration of perineum.
- W. R. MACDONALD—9.30. Arthroplasty of hip, elbow or knee.
- LOUIS E. PHANEUF—1.30. End results in cervical Cesarean section, lantern slide demonstration.
- ROOZEK C. GRAVES—2.15. Transurethral resection of the prostate. selection of cases, pre-operative preparation, operative technique, after-care of patient.

Wednesday

- F. B. LUND, D. F. MAHONEY, A. McK. FRASER, W. E. BROWNE and F. J. NASH—9.30. General surgical operations.
- W. E. BROWNE—2.45. Demonstration of end-results following treatment for injuries of musculospiral nerve, median nerve in forearm, ulnar nerve injuries at elbow in midforearm, at wrist.
- A. LEO BRETT—3.30. Demonstration of patient following operations for relief of paralysis resulting from myeloma with destruction of tenth dorsal vertebra. moving picture demonstration of operative technique in spinal cord tumors.

Thursday

- LOUIS E. PHANEUF—9.30. Hysterectomy for fibroids.
- R. J. HUFFMAN—10.30. Vaginal operation for proctodentia uteri. vaginal plastic operation for lacerations.
- LOUIS E. PHANEUF—2.45. Management of placenta pre via, lantern slide demonstration.

Friday

- F. B. LUND, D. F. MAHONEY, A. McK. FRASER, W. E. BROWNE and F. J. NASH—9.30. General surgical operations.
- W. E. BROWNE—2.45. Demonstration of end results following full thickness grafts for contractures in various parts of forearm and hand. Method of preparation of splints used and various types of splints used in this work.

CAMBRIDGE CITY HOSPITAL.

Tuesday

- H. H. GERMAIN, D. F. MAHONEY, E. J. O'BRIEN, E. D'ERRICO and E. DOWNEY—9. Dry clinic. H. H. GERMAIN. Results in surgery of the shoulder nerve suture. partial rupture of posterior cord of brachial plexus. fascial graft for recurrent dislocation of shoulder. arthroplasty of shoulder. arthroplasty for ankylosis of temporomaxillary articulation. skin graft for extensive burns. D. F. MAHONEY. End-results in fracture of pelvis and humerus. E. J. O'BRIEN. End results in transurethral resection of the prostate. massive diverticulum of the bladder in a child 2 1/4 years old. E. J. O'BRIEN. X-ray films of injuries to the head and spine. B. A. GOVITT and WALDO ROSENBERG. Orthopedic clinic: end results in fracture of hip. E. D'ERRICO. Results in injection treatment of varicose veins, moving picture demonstration. E. DOWNEY. Injection treatment of hemorrhoids, methods used and demonstration of cases.

Wednesday

- H. H. GERMAIN—9. Surgical operations. Demonstration. Nussbaum operation for leg ulcer (3 cases) tumor of the parotid (3 cases).
- Staff—9. Dry clinic. MAXWELL MACDONALD. Encephalography as an aid to diagnosis in cerebral lesions. F. G. MINOT and T. E. DINAM. Results of accessory sinus operations, demonstration of cases. R. D. YOUNG. Cesarean section. F. J. LYNCH. To be announced. J. J. MURPHY. Treatment problems of burns in general hospital. J. W. ROCKETT. Oral surgery operations. ARTHUR SARGENT and WILLIAM LAMING. Orthopedic and fracture clinic. F. O. O'BRIEN. Traumatic spine and head injuries, demonstration of X ray films. J. W. ROCKETT and F. MILLAR. Fractures of lower and upper jaw. M. SHER. Arthroplasty of lower jaw.
- E. J. O'BRIEN and L. ROCKWELL—10.30. General surgical operations.
- E. D'ERRICO—2. Acute torsion of great omentum appendicitis complicating pregnancy.

Thursday

- D. F. MAHONEY—9. General surgical operations.
- J. J. MURPHY—10.30. General surgical operations, problem of rupture of urethra, fracture of pelvis and fracture of femur.
- F. O. O'BRIEN—11. Traumatic spine and head injuries, demonstration of X ray films.

BOSTON LYING-IN HOSPITAL.

Tuesday and Thursday

- FREDERICK C. LYING and associates—9. Obstetrical operations demonstrations of premature nursery. X ray department, research laboratories, and hospital wards.
- FREDERICK C. LYING and associates—2. Dry clinic. Fetal roentgenometry. anemia in pregnancy, treatment of heart disease in pregnancy. treatment of diabetes in pregnancy; management of neglected cases of cephalopelvic disproportion. treatment of placenta previa. separation of the symphysis pubis, kidney function tests in pregnancy. classification of the albuminuric and hypertensive conditions in pregnancy. factors which make for viability in premature infants. erythroblastosis fetalis. barbiturates and other analgesic drugs in labor.

ST ELIZABETH'S HOSPITAL

Tuesday

- JOSEPH STANTON—9 Subtotal thyroidectomy
 GEORGE KIRKMAN—9 Hysterectomy
 CHARLES KIRKMAN—9 Supravaginal hysterectomy
 E. J. O'BRIEN—9 Transurethral resection of prostate
 E. M. HOOVER—10 Repair of postmastectomy hernia with peritoneal fascial strips by utilizing sac
 JOHN STELLMAN—10 Radical operation for cancer of tongue
 THOMAS BROSCHICK—10 Spine fusion
 BENEDICT BOLAND—11 Low transverse cervical section
 LAWRENCE LOOTS—11 Total thyroidectomy
 Staff—11 Dry clinic CHARLES KIRKMAN Series of spontaneous rupture of the uterus RUFELL SULLIVAN End-results of bone and joint problems LAWRENCE LOOTS Postoperative total thyroidectomy for (A) struma pectus, (B) congenitive heart disease FRANCIS P. MCCARTHY Frozen sections, demonstration and discussion of pathological specimens

Wednesday

- JOSEPH STANTON—9 Hysterectomy
 GEORGE KIRKMAN—9 Cholecystectomy
 RUSSELL SULLIVAN—9 Nephla operation for recurrence of dislocation of shoulder
 LAWRENCE LOOTS—9 Radical operation for cancer of the breast
 E. J. O'BRIEN—9 Nephrectomy for tuberculous kidney
 WILLIAM McDONALD—9 Operation for correction of childhood injury
 THOMAS BROSCHICK—10 Reconstruction of hip joint
 M. MCARTHY—10 Removal of arthralgia from knee joint
 EDWARD HOOKER—10 Repair of recurrent inguinal hernia with fascial strips
 MARTIN SPILLMAN—10 Sacro-iliac arthrodosis
 Staff—11 Dry clinic WILLIAM DUNN Industrial surgery JOHN WINTERHILL Diseases of the gall bladder medical cases either releasing operation or being surgically treated demonstration of cases FRANK JANTRICH Cholecystitis and its dysfunction (a) with hypoparathyroidism, b) with hypothyroidism
 LAWRENCE LOOTS—11 Hip graft as reconstruction of loose joint
 JAMES LEECH Diseases of spleen from a surgical standpoint THOMAS BROSCHICK Demonstration of spinal and rib spurs technique lantern slides

Thursday

- JOSEPH STANTON—9 Gastro-enterostomy
 BENEDICT BOLAND—10 Nephrectomy
 FRANK JANTRICH—10 Inguinal hernioplasty under local anesthesia
 EDWARD HOOKER—10 Gastro-enterostomy
 THOMAS BROSCHICK—10 Reconstruction of hip joint
 CHARLES KIRKMAN—10 Prolapsed uterus with perineal repair and suspension
 WILLIAM DOVANE—11 Suprapubic prostatectomy
 EDWARD O'BRIEN—11 Suprapubic cystostomy
 MICHAEL MCCARTHY—11 Fascial repair of double rectal and inguinal hernia
 BENEDICT BOLAND—11 Tubal plastic for sterility
 Staff—11 Dry clinic WILLIAM O'HALLORAN Medicine from a pre-operative and postoperative standpoint BENEDICT BOLAND Discussion of diagnosis of carcinoma of bladder WILLIAM McDONALD Polypus in pregnancy JAMES LEECH Valvular phlebitis complicating pregnancy antenatal JOSEPH STANTON Hypocalcemia of unusual origin, gastric ulcer demonstration of interesting clinical cases

BOSTON DISPENSARY

Tuesday

- Tumor clinic staff—9 Dry clinic FRANK B. MARVIN Anesthetics in operative cases CHARLES M. PROCTOR Precociousness and benign lesions of the oral cavity CHARLES E. DUNN Radium techniques in malignancy of the throat LEROY A. BOWALL Treatment of cancer of tonsil GEORGE S. SETZLER Malignant degeneration of sebaceous cysts LOUIS E. FRANKLIN Precociousness lesions and cancer of the cervix, batters slide demonstration ALICE EITZINGER Early diagnosis of malignancy of gastro-intestinal tract by x-ray method HAROLD A. CHAMBERLAIN Papillary tumors of the kidney pelvis ROGER C. CHATMAN Management of cancer of penis with particular reference to a modified operation for advanced cases MYRON J. BAKER Cancer of the prostatic capsule ISACORE OLIVER Management of malignancy of the lymphatic system HILBERT F. DAY Cancer of breast, end-results JOSEF KRONENBERG Bleeding carcinoma of breast without tumor WILLIAM M. SHERROD Management of cancer of rectum with particular reference to irradiation HAROLD MCMAHON Relation of pathology department to tumor clinic

Wednesday

- Staff—10 Dry clinic OLIVER G. TUCKERMAN Clinical teaching of third year medical students FRANCIS P. BARNETT Use of adhesive plaster P. A. CORRIE Adenomatous changes in abnormal thyroid HILBERT F. DAY Management of a varicose vein clinic, where over 30 treatments a week are given EDWARD T. WINTERHILL Varicose veins, demonstration of cases and treatment WALTER S. LUTERSON High injection of varicose veins WILLIAM M. SHERROD Injection treatment of varicocoele S. SHERROD ROSSIGNOL Results of multiple injections of varicose veins at same time HILBERT F. DAY Results of return of strength following injection treatment

Thursday

- Staff—9 Dry clinic JOHN D. ADAMS Smaller-Christie disease (osteochondroma) bone tumors RAY E. MAHONY Chondroma and chondrosarcoma WILLIAM A. HINTON Detection of syphilis as an aid in practice of surgery FRANCIS M. TETTERSON Syphilis and the differential diagnosis of surgical conditions JOSEPH SEIZBALL Ophthalmic studies in syphilis GEORGE E. ROCKFORD An unusual gynecological condition LOUIS A. O. GOODE Pain in the shoulder girdle ROBERT W. BICE Kidney function, renal function tests WILLIAM E. DAVIS Some observations in treatment of peptic ulcer in out-patient clinic ALICE EITZINGER Diagnosis of activity of duodenal ulcer by X-ray KATHERINE S. ANDREWS Hysteria hernia HILBERT F. DAY Solitary gall-stone pain relieved by posture Demonstration of interesting X-ray plates of peptic ulcer and gall-bladder disease

LAKEVILLE SANATORIUM

Wednesday

- Z. B. ADAMS—9 30 Ankylosis of hip, operative Ward rounds
 Staff—9 Dry clinic Tuberculous of lymph nodes, gastro-intestinal tract, eye, gastro-intestinal tract, peritonitis, and skin
 Z. B. ADAMS—9 Orthopedic dry clinic

BETH ISRAEL HOSPITAL

Monday

- Staff—4.30. Dry clinic JOHN SEARS Prophylactic vein ligation against embolism from phlebitis of the internal saphenous vein. MAXWELL BLOOMBERG The prevention of scar tissue by the use of baudruche, experimental and clinical experiences, demonstration of cases. WALTER S. LEVINSOHN Intraperitoneal adhesions. A LOUIS HERMANSON Transfusions during active bleeding from peptic ulcer. AARON TRUENMAN Surgical treatment of cholecystitis. JOSEPH MIZEL Subacute pancreatitis. BORIS RAPAPORT Complications of postoperative complications following spinal and general anesthesia.

Tuesday

- Staff—9. Symposium on total thyroidectomy for chronic heart disease and angina pectoris. HERMAN L. BLUMGART Rationale of total thyroidectomy in chronic heart disease. JOSEPH RISEMAN End-results of total thyroidectomy in angina pectoris. DAVID DAVIS End-results of total thyroidectomy in congestive heart failure. HERMAN L. BLUMGART Indications and contra-indications for surgery selection of cases. CHARLES G. MIXTER General surgical considerations in total thyroidectomy. DAVID D. BERLIN Technical considerations in total thyroidectomy. DAVID DAVIS Treatment of postoperative complications. DOROTHY GILLIGAN Parathyroid insufficiency following total ablation of the thyroid gland. MARK ALTSCHUL and ALFRED WEINSTEIN Total thyroidectomy moving picture demonstration demonstration of cases. CHARLES G. MIXTER, DAVID D. BERLIN and associates—1. Total thyroidectomy.

Wednesday

- E. GRANVILLE CRABTREE and associates—9. Dry clinic, symposium on the female bladder. Demonstration of various factors related to function in health pregnancy and disease the use of urethrogram and cystogram in the diagnosis of bladder displacements and deformities in the multiparous woman, results of roentgen surgery in such cases treatment of infections in the abnormal bladder.
- W. JACOB MIXTER—9. Craniotomy.
- Staff—5. Dry clinic CARL BEARER Acute appendicitis beyond the age of fifty. W. JACOB MIXTER Subject to be announced. ARNOLD STARR Effect of diaphragmatic paralysis on the efficiency of cough. JACOB FINE Postoperative distention, an experimental study. LOUIS NASON Gas bacillus infection complicating laparotomy. BENJAMIN BANKER Differential diagnosis of jaundice. I. R. JAMELSON Indications for ileostomy in ulcerative colitis. CHARLES G. MIXTER Regional ileitis. MAURICE BARON Is radical resection for carcinoma of the rectum the best procedure?

Thursday

- Staff—9. Symposium on total thyroidectomy for chronic heart disease and angina pectoris. HERMAN L. BLUMGART Rationale of total thyroidectomy in chronic heart disease. JOSEPH RISEMAN End results of total thyroidectomy in angina pectoris. DAVID DAVIS End results of total thyroidectomy in congestive heart failure. HERMAN L. BLUMGART Indications and contra-indications for surgery selection of cases. CHARLES G. MIXTER General surgical considerations in total thyroidectomy. DAVID D. BERLIN Technical considerations in total thyroidectomy.

DAVID DAVIS The treatment of postoperative complications. DOROTHY GILLIGAN Parathyroid insufficiency following total ablation of the thyroid gland. MARK ALTSCHUL and ALFRED WEINSTEIN Total thyroidectomy moving picture demonstration.

- CHARLES G. MIXTER, DAVID D. BERLIN and associates—2. Total thyroidectomy.

- E. GRANVILLE CRABTREE and associates—2. Bladder surgery operative and dry clinic.

Friday

- MARK ROGERS and associates—9. Orthopedic dry clinic. Methods and results of manipulation of subdeltoid bursitis, slipping epiphysis, femoral neck club foot, demonstration of application of plaster cast method of drainage of septic knee, posterior incision atresia, tenovaginitis, operative results. Nicola operation, end results in three cases of recurrent dislocation of the shoulder marble bones, repeated fracture of the femur fractures of the long bones in Paget's disease, compression fractures of the spine in diabetes and old age, correction of hallux valgus, temporary paralysis of the sensory nerve affecting the joint.

- CHARLES G. MIXTER and associates—9. General surgical operations.

- Staff—10.30. Dry clinic WILLIAM DAMESHEK Blood changes in surgical conditions. HYMAN MORRISON Nonsurgical simulating acute surgical disease. HARRY DEROW Significance of postoperative rise in non protein nitrogen. ARNOLD STARR and S. RICHARD MUELLER Postoperative renal suppression. CHARLES G. MIXTER Surgery of the large intestine. S. GAROHL and M. FALCOV-LESER Thyroid clinic experiences. E. GRANVILLE CRABTREE and associates—5. Renal surgery.

- Staff—2. Symposium on tumors. WILLIAM DAMESHEK Malignancies of the blood forming organs. HARRY F. FRIEDMAN and LOUIS M. FRIEDMAN Laryngeal carcinomas, diagnosis and treatment, presentation of cases. REUBEN B. DAVIDOFF Differential diagnosis of breast tumors. CHARLES G. MIXTER Surgical treatment of breast tumors. HARRY F. FRIEDMAN Radiation treatment of breast tumors. MONROE J. SCHLESINGER The diagnosis of malignancy from acid and pleural fluids. HARRY F. FRIEDMAN and LOUIS ALBERT Policy toward married women in regard to carcinoma of the uterine cervix. JACOB H. SCHWARTZ Diagnosis of carcinoma of the skin. HARRY F. FRIEDMAN Carcinoma of radium treatment of carcinoma of skin. SAMUEL A. ROBBINS Roentgen diagnosis of renal tumors. E. GRANVILLE CRABTREE Surgery in renal tumors. GEORGE C. PRATHER Results of surgery in renal tumors testicular tumors.

Daily Exhibit in Medical Research Laboratories

- WILLIAM DAMESHEK Blood changes in surgical conditions. HERMAN L. BLUMGART Total thyroidectomy for chronic heart disease. HARRY A. DEROW Renal function tests in surgery. SAMUEL A. ROBBINS Demonstration of interesting or unusual X-ray films. MONROE J. SCHLESINGER Surgical pathological specimens.

SYMMES ARLINGTON HOSPITAL

Tuesday

- F. J. COTTON—9. Bone and joint surgery.
A. L. BRETT—9. Tumor of the spinal cord shoulder arthrodesis.
G. P. TOWLE—9. General surgery.
S. G. JONES—9. Volkmann's paralysis.

HARVARD MEDICAL SCHOOL

Monday

- G KIMBLE COOPER and OTTO AYERMAN—2 (Bldg. C) Demonstration of the mechanical factors controlling the pulmonary circulation
- CHARLES L. SCUDDER and associates—2 (Bldg. E) Conference on fractures of the neck of the femur. A. W. REES—2 Results of nonoperative treatment up to 934, lantern slide demonstration. RALPH LEE and ROBERT VANCE. Roentgenological findings. JOSEPH FAY. HENRY MARBLE, JOHN ANDERSON and OTTO REES. Reports of cases treated with aid of lateral view. M. N. SMITH-PETERSON. Operative treatment with roentgen, moving picture demonstration. JOHN O'BRIEN. Operative treatment results lantern slides

Tuesday

Building D—2

- GEORGE B. WIMLOCK. Studies in mammalian reproduction
- VARY MCKEN. Some problems of inflammation related to surgery
- HENRY G. SCHWARTZ. An experimental study of synovial effusions
- J. L. BRIDGER. The postnatal growth of the mammalian lung
- HAROLD L. WEATHERSTON. The inner changes in the liver cells in anaphylactic shock
- LESTER M. WISE. A study of the human cephalic barrier

Building C—

- G. A. BRYANT and WALTER BIER. Joint changes resulting from trauma
- HELEN W. JON. Surgical infections
- CURTIS B. DUNN. The physiology of the lymphatic system and its bearing on certain problems in surgery

Wednesday

Building C—

- H. LLOYD DILL. Effect of cerebral anoxia on the electrical response of the testes
- M. I. CURETAN. The use of hypertonic saccharine solution to reduce cerebrospinal fluid pressure without a sacculotomy
- WALTER B. LUNN. Some relations of the sympathetic nervous system to surgery

Building B—2

- D. WIDENER. The surgical anatomy of the abdominal aorta and its branches

Building E—2

- FRANK OBER and associates. Orthopedic problems from Children Hospital. A. H. BREWSTER. Scoliosis. J. KIRBY. Posture and postural poisons. H. FLETCHER. Congenital deformities. P. NORTON. Posterior transplants

Thursday

- THEODORE LEAHY, DONALD MERRILL W. J. MINSTER, J. S. BAIRD and WILLIAM A. ROBERTS—2 (Bldg. E) Conference on trauma to the head and spine

Friday

- Symposium on Industrial Surgery—2—Building C
W. A. ROBERTS. Injuries of the back

- HENRY MARBLE, F. J. CORCORAN and J. D. ADAMS. Injuries of the nervous system
F. J. CORCORAN. Colles' fracture
J. H. BUNNETT. Carpal fractures

Orthopedic Clinic—Building E

- J. W. SEVER. Obstetrical paralysis
W. GERTZ. Osteomyelitis in infants and children
R. H. MORRIS. Septic hips with unopened heads
A. T. LEECH. Osteomyelitis of the tarsus
R. JOHNS. Intracerebral duct—embryology, anatomy, physiology and pathology
A. H. BREWSTER. Peroneal spasm
R. H. MORRIS. Septic hips with unopened heads

Daily

- Warren Museum—M. CANAVAN, Curator—2
Demonstration of Dwight collection of spines illustrating deformities, anomalies, diseases. Bone tumors, with X-rays, histories, and microscopic slides, with microscopes available for examination (some of these specimens were used in the illustrations in the monograph on Bone Tumors issued by the American College of Surgeons). Models showing various types of club feet and effects of operation. Pictures illustrating pathological conditions of bones in Dr. Nichols' collection. Fractures and dislocations of bones as they existed before industrial plants provided so many safeguards. Tuberculosis of bones and joints. Syphilis of bones. Dislocation of ends of bones. Old surgical instruments, obstetrical forceps, forceps for extracting teeth, otological tools, clippings and dressing instruments.

MASSACHUSETTS MEMORIAL HOSPITALS

Monday

- Staff—2 Dry clinic. GEORGE LEVINE. Demonstration of mechanical heart. WILLIAM D. RICE. Discussion of certain ostealgias in connection with cardiac disease. LEE MACPHER. Liver function after cholecystitis. DR. DUNN. Report on some audiograms done in breast tumor cases, before and after operation. JAMES J. JACOBY. Water metabolism. ALLEN RUBY. Subject to be announced. SUMNER R. MEAKER. Investigation and treatment of the sterile menses

Tuesday

- Staff—2 Dry clinic. ALICE C. O'BRIEN. Reaction of the ascending colon. CLIFFORD HARVEY. Gall-bladder disease in children. W. E. S. THOMAS. Abdominal surgery. CHARLES SELLERS. Subject to be announced. FRANK BARTON. Thyroid treatment. LOUIS G. HOWARD. Fracture of the hip

Daily

- Staff—2 Operative clinics

CHELSEA MEMORIAL HOSPITAL

Thursday

- Staff—2 Dry clinic. CHARLES P. SHELTON. Septic abortion. LEWIS W. B. ROCKWELL. Perforated duodenum. GEORGE A. MARSH. Acute appendicitis with peritonitis. SYLVESTER B. KELLEY. Causes of death in prostatitis

- Staff—2 General surgical operations
Staff—2 Dry clinic. CONNOR MORGAN. Abdominal trauma. STEPHEN G. JONES. Volkmann's contracture. ALBERT VON P. ARNETT. Epiphyseal separation of the radius. JOHN S. HOROVITZ. Fracture of the skull. Discussion by FREDERICK J. CORCORAN

NEW ENGLAND DEACONESS HOSPITAL

Tuesday

F H. LAHEY H. M. CLUTE, R. B. CATTELL and R. H. OVERHOLT—9. General surgical operations.

GILBERT HORRAX and JAMES POPPER—9. Neurosurgical operations.

RICHARD H. OVERHOLT—9. Thoracic surgery operations.

G E. HAGGART—9. Orthopedic operations.

JAMES B. HICKS—9. Urological operations.

LINCOLN F. SISK, PHILIP D. WOODBRIDGE and URRAN EVERSOLE—9. Anesthesia.

F H. LAHEY—9. Esophageal diverticulum, dry clinic.

GILBERT HORRAX—9. Malignant exophthalmos, dry clinic.

Staff—1. Dry clinic. H M. CLUTE. Management of obstructive jaundice. Exploration of common duct.

GILBERT HORRAX. Brain tumors, malignant exophthalmos. SARA M. JORDAN. Gastric cancer and ulcer.

gastrojejunal ulcer. F H. LAHEY. Total gastrectomy for cancer. gastrojejunal colic fistula, surgery of intractable ulcer. EVERETT KIEFER. Hemorrhage in peptic ulcer. RICHARD B. CATTELL. Embolectomy.

parathyroid tetany.

Wednesday

F H. LAHEY H. M. CLUTE, R. B. CATTELL and R. H. OVERHOLT—9. General surgical operations.

GILBERT HORRAX and JAMES POPPER—9. Neurosurgical operations.

RICHARD H. OVERHOLT—9. Thoracic surgery operations.

G E. HAGGART—9. Orthopedic operations.

JAMES B. HICKS—9. Urological operations.

LINCOLN F. SISK, PHILIP D. WOODBRIDGE and URRAN EVERSOLE—9. Anesthesia.

Staff—1. Dry clinic. G E. HAGGART. Subdeltoid bursitis. Treatment of flexion deformities. JAMES L. POPPER. End results in trigeminal neuralgia. Spinal fluid pressure dynamics. FRANK H. LAHEY. Esophageal diverticulum. Hyperthyroidism. H M. CLUTE. End results in hyperthyroidism. LEWIS M. HURSTHALL. Thyrocardiac patients. EVERETT KIEFER. Ulcerative colitis. RICHARD B. CATTELL. Surgical treatment of ulcerative colitis. RICHARD OVERHOLT. Limited thoracoplasty in pulmonary tuberculous cancer of lung.

Thursday

E P. JOSEPH H. F. ROOT L. S. MCKITTERICK and T. C. PRATT—9. Surgical and medical diabetic ward rounds.

T. C. PRATT—10 30. Thigh amputation for diabetic gangrene.

L. S. MCKITTERICK—10 30. Gritti-Stokes amputation for diabetic gangrene.

Staff—1. Dry clinic. Surgery in diabetes mellitus. E P. JOSEPH. Medical care of the surgical patient. L. RICHARDS. Otolaryngological aspect of diabetes. H. F. ROOT. Preventive measures in gangrene and infection of the lower extremities. L. S. MCKITTERICK. Factors influencing the level of amputation. T. C. PRATT. Indications for guillotine amputation. R. S. TITUS. Obstetrics in diabetes. MARK ROGERS. Depressed fracture of the spine in diabetes. subdeltoid bursitis in diabetes mellitus.

Friday

F H. LAHEY H. M. CLUTE, R. B. CATTELL and R. H. OVERHOLT—9. General surgical operations.

GILBERT HORRAX and JAMES POPPER—9. Neurosurgical operations.

RICHARD H. OVERHOLT—9. Thoracic surgery operations.

G E. HAGGART—9. Orthopedic operations.

JAMES B. HICKS—9. Urological operations.

LINCOLN F. SISK, PHILIP D. WOODBRIDGE and URRAN EVERSOLE—9. Anesthesia.

Staff—1. Dry clinic. R. B. CATTELL. Cancer of the colon and rectum. GILBERT HORRAX. Root resection for trigeminal neuralgia. cordotomy for pain. JAMES POPPER. Spinal cord tumors. RICHARD OVERHOLT. Cancer of the breast. JAMES B. HICKS. Transurethral resection of the prostate. H. M. CLUTE. Subphrenic abscess. F H. LAHEY and FRANK N. ALLAN. Para-thyroid tumors. J. H. WAITE. Cataract surgery in diabetes mellitus.

PETER BENT BRIGHAM HOSPITAL

Monday

DAVID CHEEVER—2. Surgical clinic.

H. F. NEWTON—3. Thoracoplasty.

S. A. LEVINE—3 30. Circulatory emergencies in surgical patients.

Tuesday

Staff—9. General surgery. operative clinic.

E. C. CUTLER—2. Total thyroidectomy.

C. L. DEMICK—3. Symptoms and diagnosis of vascular thrombosis.

JOHN HOWARD—3 30. Swollen legs.

Wednesday

Staff—9. General surgery. operative clinic.

HENRY A. CHRISTIAN—2. Medical clinic.

M. C. SOSKIN—3. Recent developments in diagnostic radiology.

E. S. EMERY JR.—3 30. Results of surgical procedures for relief of peptic ulcer.

Thursday

Staff—9. General surgery. operative clinic.

W. C. QUINN—2. Indications for and results of total cystectomy.

J. C. ECKELS and G. P. GRANTFIELD—2 30. Denervated kidney studied by means of the divided bladder.

M. S. STROCK—3. Methods of fixation of fractures of the jaw.

S. B. WOLBACH—3 30. Surgical pathology.

Friday

Staff—9. General surgery. operative clinic.

DAVID CHEEVER—2. Cancer of the stomach.

F. C. NEWTON—2 30. Cancer of the rectum.

R. FITZ—3. Function of the spleen.

W. P. ALLEN—3 30. Treatment of pernicious anemia, motion picture demonstration.

F. R. OSER—3 45. Treatment of neuromuscular sequelae of pernicious anemia.

INDUSTRIAL SURGERY

Tuesday

H. C. MARBLE and H. P. TOWLE (143 Berkeley Street)—9.

D. L. LYNCH and B. A. GODWIN (145 State Street)—9.

Wednesday

G. W. MORSE (31 St. James Avenue)—9.

Thursday

WILLIAM DOLAN (110 Milk Street)—9.

Friday

J. H. SHORRELL (260 Tremont Street)—9.

D. L. LYNCH and B. A. GODWIN (145 State Street)—9.

FAULKNER HOSPITAL

Wednesday

- F J COTTON E. G. BRACKETT and associates—9. Bone and joint clinic, operative and dry
 Staff—2. Dry clinic. E. G. BRACKETT Lame back.
 F J COTTON Bone tumors fractures of pelvis.
 H. C. MARBLE Hand surgery; fractures of the forearm.
 J. D. ADAMS Traumatic knees WILLIAM A. ROGERS Compression fracture of spine. E. A. CODMAN Shoulder lesions. B. A. GODVIN On calcia fractures. W F COTTING Ankle fractures. H. K. SOWLES Elbow fractures. Demonstration of X-ray plates and pathological specimens. G L. DORRERY Arm fractures J F GIBSON Case of multiple fractures

Thursday

- E. L. YOUNG JR., R. C. COCHRANE, A. R. KIMPTON and associates—9 Operative clinic.
 J R. TORRIST and R. S. TRUSS—11 Obstetrical clinic
 S. W. WIGGINS—11 Postoperative pulmonary complications
 Staff—2 Symposium on pre-operative immunization of the peritoneal cavity H. L. JOHNSON Theoretical and experimental evidence of the benefit of amfetin
 E. L. YOUNG JR. and EVERETT O'NEIL Clinical evidence of immunity from amfetin injection. R. C. COCHRANE and BURTON HAMILTON Total thyroidectomy for heart disease. F G BALCH, JR. Injection treatment of hemorrhoids

COLLIS P HUNTINGTON MEMORIAL HOSPITAL

Monday

- Staff—2:55 Tumors and diseases of bones, dry clinic
 J C. AUB Calcium metabolism in diseases of the bones. CHANDLER C. SIMMONS Malignant tumors of bone. RICHARD DRESNER Radiological diagnosis of bone tumors and certain rare forms of skeletal diseases
 C. C. FRANKEN The phosphatase content of the blood in bone tumors and skeletal diseases
 GEORGE A. LECLAND and J V MEIGS—3:30 Carcinoma of the cervix.

Friday

- Staff—2:15. Carcinoma of the oral mucous membrane, dry clinic. CHANDLER C. SIMMONS Choice of treatment in the individual case. C. C. LUND Results of treatment of cancer of lip. GRANTLEY W. TAYLOR Carcinoma of the mouth in the female. RICHARD DRESNER Radiation treatment of oral carcinoma. CHARLES B. HOPKINS Prophylaxis of cancer of the mouth. SOMERS STRINGS Electrical currents between fillings of different metals as an etiological factor in leucoplakia and carcinoma of the mouth.
 E. W. HERMAN and LEROY A. SCHALL—3:30 Carcinoma of the accessory sinuses, tonsils, and larynx.

MASSACHUSETTS WOMEN'S HOSPITAL

Thursday

- HENRY T. HUTCHINS—9 Panhysterectomy
 STEPHEN RUSKORF—9 Plastic laparotomy
 WILLIAM A. WHITE, JR.—9. Laparotomy
 REYNOLD MARSHALL—9. Transverse cervical cesarean section.
 ROBERT L. MARSON—9 Thyroidectomy
 Staff—3 Dry clinic. CHARLES H. LAWRENCE Endocrine sterility end-results DONALD MACOMBER Problems of sterility CHARLES F. PADGETT Congenital obturator dislocation of right hip causes of eburnation of bone. J STEWART ROOSEY Pathological specimens.

FREE HOSPITAL FOR WOMEN

Tuesday

- F A. PEMBERTON G V SMITH and S C. GRAVER—9. Operative and dry clinic Carcinoma of cervix uteri, treatment and results, prevention, diagnosis of early cases, relation to cervicitis and its treatment, complications of radium treatment, relief of pain carcinoma of fundus uteri, treatment and results, classification other tumors of uterus—fibroids, adenomyoma.

Wednesday

- F A. PEMBERTON G V SMITH and PAUL YOUNG—9. Operative and dry clinic Tumors of the ovary diagnosis, treatment, and results. Cystadenoma, granulosa cell tumor Brenner tumor teratoma, endometriosis, diagnosis and treatment tumors of tubes, round ligaments, and vagina.

Thursday

- G V SMITH and JOHN ROCK—9 Operative and dry clinic Sterility diagnosis, treatment and results, menor rhagia and metrorrhagia, diagnosis, treatment and results endocrine research dysmenorrhea.

Friday

- F A. PEMBERTON, E. B. SHEEHAN and S. C. GRAVER—9 Operative and dry clinic Prolapse, procidentia, complete tear of perineum vesico- and rectovaginal fistulae knarous vulva, carcinoma vulva: Trichomonas vaginalis tumors of breast, value of X ray treatment.

PONDVILLE STATE CANCER HOSPITAL

Tuesday—2

- ERNEST M. DALAND The Massachusetts cancer program.
 HENRY JACKSON JR. Some aspects of malignant lymphoma.
 JOE V. MELOS Ovarian tumors.
 LANGDON PARSONS Treatment of cancer of the cervix by X ray followed by radium.
 ROGER GRAVES. Cancer of the prostate with metastases
 CHARLES KICKHAM Cancer of the penis.
 CHARLES DUMAS. X ray treatment of advanced skin cancer
 Demonstration of cases.

Friday—2

- GRANTLEY TAYLOR. Radium needles in cancer of breast.
 HORATIO ROGERS. Chronic cystic mastitis.
 RICHARD DRESNER. X ray in the diagnosis of gastrointestinal cancer
 SHELTON WARREN Changes in tumor tissue caused by radiation.
 JOHN HODGSON Treatment of pain in cancer patients
 CARL EDLUND Cancer of the antrum.
 Demonstration of cases.

STATE PRISON COLONY

Thursday

- HILBERT DAY Practice of medicine in a modern correctional institution.
 WILFRED BLOOMBERG. Psychiatric approach to prison medicine.
 HENRY R. CRAIG. Unusual incidence of peptic ulcer in a prison population.
 GEORGE H. LYONS. Minor surgical injuries in a protected population.
 GEORGE ROTENBLATT Dental conditions causing personality changes.

MARGARET NOYES KLEINERT—New England Hospital for Women and Children—930. Mastoidectomies in infants

C. W. BOWEN, R. O. PARKER and B. A. WILCOX—Massachusetts Memorial Hospitals—10. Operations

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room—10. Demonstration of historical instruments

WILLIAM T. HALL—St. Elizabeth's Hospital—11. Operation for correction of dislocation of nasal septum

H. L. BARCOCK—Massachusetts Memorial Hospitals—2. Otological problems in contagious diseases

LEONARD F. JOHNSON—Massachusetts Memorial Hospitals—3. Otolaryngological clinic

II. P. MOSELEY—Harvard Medical School, Bldg. B—2. Evaluation of anatomical cases demonstrating the anatomy of the nose and throat, discussion of teaching methods, demonstration on the cadaver of the submandibular approach for deep penetration in the neck. P. E. MESSITER and M. H. LUTER. Evaluation of specimens illustrating the anatomy of the ear

Staff—Beth Israel Hospital—3. L. M. FRIEDMAN. Experiences with vocal cord paralysis in thyroidectomy. JACOB FINE. Technique for relief of bilateral recurrent nerve injury. CHARLES GERTNER. Demonstration of technique for eliciting vestibular reactions by galvanism. I. M. FRIEDMAN. Jugular puncture in mastoiditis. S. CLINE. Tuberculous laryngitis and its treatment. S. GARTIN. Treatment of malignant tumors of the upper respiratory tract. L. M. FRIEDMAN. Bronchoscopic studies

WEDNESDAY

Staff—Massachusetts Eye and Ear Infirmary—9. Operations and demonstration of cases

WALTER B. HOOVER—New England Descomens Hospital—9. Operations

Staff—Children's Hospital—9. LYMAN RICHARDS. Acute laryngotracheobronchitis. MAURICE EVANS. Bilateral jugular ligation and its neurological complications. PHILIP MIVERT. Cerebral abscess. CHRISTINE MILLIS. Sinusitis. JORIAN E. QUINCY. Radical mastoid operation. CHARLES ALLMAN. Unusual foreign bodies. ELMER GILBERT. Complications in simple mastoidectomy. SAMUEL CLINE. Cases of sinus thrombosis

HARRY J. IWLES and associates—Boston Dispensary—9. Dry clinic. LOUIS WOLKOW. Bronchoscopy in the upright position as an out-patient procedure. A. I. CORBIN. F. B. DUNHAM and FRANCIS STEIN. An improved method of skin testing in allergic disturbances

F. O. MONTGOMERY and associates—Carney Hospital—9. Operations and demonstration of cases

LEIGHTON F. JOHNSON—Massachusetts Memorial Hospitals—1. Bronchoscopic operative clinic

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room—9. Demonstration of historical instruments

JOHN BURTON—St. Elizabeth's Hospital—11. Radical sinus operation under nerve block

A. W. ROWE and D. W. DRAURY—Massachusetts Memorial Hospitals—2. Endocrine factors in deafness

THURSDAY

Staff—Massachusetts Eye and Ear Infirmary—9. Operations and demonstration of cases

WALTER B. HOOVER—New England Baptist Hospital—9. Operations

E. J. RUTLAND and C. H. ALLMAN—Cambridge Hospital—9. Operative and dry clinic. Hematogenous infection of left mastoid with extradural abscess in a nine months old child, pneumococcus type III meningitis with labyrinthitis, demonstration of case

F. O. MONTGOMERY and associates—Carney Hospital—9. Operations and demonstration of cases

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room—10. Demonstration of historical instruments

C. FAIRBANK—Faulkner Hospital—11. Operations and demonstration of cases

WILLIAM T. HALL—St. Elizabeth's Hospital—11. Radical operation for maxillary antrum

JOHN BURTON—St. Elizabeth's Hospital—11. Radical mastoid operation

FRIDAY

Staff—Massachusetts Eye and Ear Infirmary—9. Operations and demonstration of cases

WALTER B. HOOVER—New England Descomens Hospital—9. Operations

F. O. MONTGOMERY and associates—Carney Hospital—9. Operations and demonstration of cases

Staff—Massachusetts Eye and Ear Infirmary—9. Dry clinic. H. P. CANNILL. The present status of brain abscess from the standpoint of the otologist. P. E. MESSITER. A twelve year summary of cases of lateral sinus thrombosis at the Infirmary. P. MIVERT. A ten year review of cases of labyrinthitis at the Infirmary. D. C. SMITH. Chest cases requiring bronchoscopy, lantern slide demonstration. A. S. MACMILLAN and D. C. SMITH. The accessory sinuses from the standpoint of the roentgenologist and the clinician. A. S. MACMILLAN. Petrositis from the X-ray standpoint. G. H. POORE. Result of the Mosher Todd test operation. M. H. LUTER. Histological slides showing the pathological condition of the internal ear. E. W. HERMAN. Radium and X-ray treatment of cancer of the larynx. HARRY P. MOSELEY. Notes on esophageal cases. F. E. GARLAND. Surgery of the submandibular gland. C. G. PAGE. Fungi in tracheal and bronchial mucous. GEORGE L. TOBEY, JR. The Tobey Ayer test

F. E. GARLAND—Massachusetts Eye and Ear Infirmary Hooper room—9. Demonstration of historical instruments

SURGERY, GYNECOLOGY AND OBSTETRICS

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THE KIDNEY PELVIS

A FURTHER CONTRIBUTION TO ITS PHYSIOLOGY AND PATHOLOGY

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In previous communications the author has drawn attention to the normal physiology of the kidney pelvis and to the value of pyeloscopy and pyelometry in the clinical investigations of the pathological kidney and in determining the etiology of 'kidney pain'.

The author would in the first place like to express his deep regret that reference was not made in these papers to the pioneer work of Willis Manges in 1912. This work was quite unknown to him until his attention was recently drawn to the fact by a colleague. The author would like to state that he in no way attempted in his communications to lay claim to any priority in this work as in his communications he made reference to the fact that he had been attracted to this line of investigation by the work of French observers in 1926-7.

In the present communication an attempt will be made to collate briefly the results obtained by pyeloscopy and pyelometry in about 100 patients with the clinical symptoms and the pathological findings as disclosed by other methods of investigation where such have been obtained and to illustrate various types. All the cases illustrated are women

as would pass being used. The kidney pelvis (in the earlier cases) was then filled with the radio-opaque material and pyeloscopy was performed and the tracing obtained (pyelometry). The pelvis was then refilled with the radio-opaque material and a pyelogram obtained. In the later cases (the majority) the technique was simplified in that the tracing was obtained first the kidney pelvis was then filled under vision, its capacity determined the contractions of the calyces and body of the pelvis ("ventricle") studied, and the passage of the "globule" down the ureter observed. A pyelogram was taken with the catheter still in the ureter. The catheter was then withdrawn and another picture was taken immediately. In regard to the method of obtaining the graphic record of contractions of the kidney pelvis and variations of the intrapelvic pressure the technique followed in this investigation has been similar to that previously described (Jona and Flecker) except that advantage has been taken of a trick of technique adopted by Trattner in his work on ureterography in which he injects fluid into the ureter to determine its capacity and to induce expulsive contractions. It was found, however that injecting the fluid with a hypodermic or serum syringe often involved the use of a great deal more pressure into the pelvis than was good for the patient judging by the

TECHNIQUE

The ureter was first catheterized as large a catheter preferably No. 7 or 8 Charrière

painful response evoked. The apparatus was therefore slightly modified by connecting the reservoir via a T piece and a stop cock with a burette the height of which above the patient could be adjusted and the water run into the pelvis at a pressure of 30 to 50 centimeter water pressure from the burette and immediately stopped when the patient complained of pain.

RESULTS

It would not be out of place first to refer to an interesting phenomenon observed in many pyelograms of a class of patients who suffered from chronic kidney pain and in whom filling of the kidney pelvis was accompanied by great and often persistent pain comparable with the pain for which she was seeking relief. In the class of patients referred to the capacity of the pelvis as indicated by the amount of contrast fluid which could be injected before this pain was elicited was generally 2 to 5 cubic centimeters and it was found that the

pyelograms invariably showed filling of the collecting tubules and injection of the kidney substance (Fig 1). Pyeloscopy and the pyelogram in these cases showed a condition of spasm of the calyces and of the body of the pelvis ('ventricle') accompanied by relaxation of the communicating channels and also of the ureter in its upper two-thirds although there was generally some spasm in the ureter in its lower part. When the calyces contracted the contrast material used for the pyeloscopy and pyelogram generally passed readily into the body of the pelvis and the globule formed in the upper ureter was passed readily down the ureter to the region of spasm where it was temporarily held up and then passed on into the bladder. The author considers that this hold up is responsible for the patient's kidney pain. The urine produced by the secreting apparatus of the kidney is passed into the collecting tubules but cannot enter the calyces on account of their spasm and is thus dammed

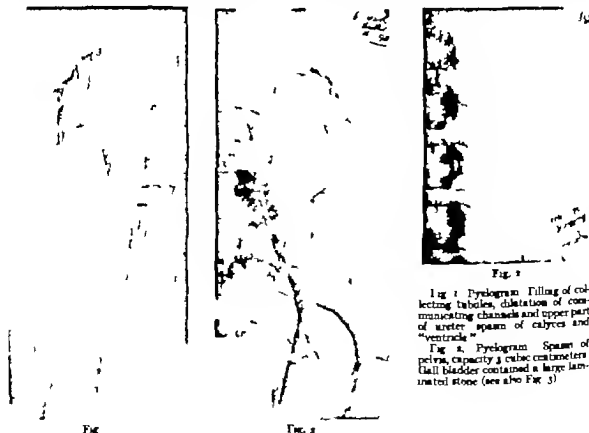


Fig. 1. Pyelogram. Filling of collecting tubules, dilatation of communicating channels and upper part of ureter; spasm of calyces and "ventricle."

Fig. 2. Pyelogram. Spasm of pelvis, capacity 3 cubic centimeters. Gall bladder contained a large laminated stone (see also Fig. 3).

Fig. 3 Catheter stopped at about 3 centimeters from pelvis at spasm in ureter in relation to a slight kink in the ureter. All calyces contracted well but apparently in a condition of spasm. Capacity of pelvis 3 cubic centimeters. Vomited bile on injecting fluid into kidney pelvis. Hold-up of globule at 3 centimeters from pelvis in region of tip of catheter and occasional antiperistalsis. Pyelogram also shows apparently laminated stone in relation to upper pole of kidney. Cholecystography confirms presence of stone in gall bladder. Cholecystectomy. Relief.

back into the collecting tubules and pain results. If the author's suggestion that there is a normal "maintenance filling" of the calyces and pelvis (Jona, 1) is accepted then one might say that in these cases on account of the condition of spasm in the calyces and pelvis there is no (or diminished) maintenance filling of the pelvis or calyces. Thus any resistance to outflow from the ureter (either by spasm in the ureter or temporary obstruction or kinking by some extraneous cause) will immediately result in damming back of urine directly into the kidney tubule system with sensation of pain and impairment of secretory activity. Whether the dilatation of upper ureter communicating channels and collecting tubules associated with spasm of the intervening "ventricle" of the pelvis and the calyces is the result of a reciprocal innervation such as one would expect to exist between a sphincter (or a duct) apparatus and a detrusor apparatus respectively cannot be stated but this would be a more satisfactory explanation than mechanical dilatation due to back pressure. The causation of this condition of spasm is often difficult to elucidate but in most cases it could be attributed to some pathological condition in an overlying viscus such as the colon or appendix or a viscus with related innervation such as ovary fallopian tubes gall bladder or appendix or some pathological condition in the cellular tissue in relation to the ureter, generally the result of some previous operation or inflammation. Thus a pathological appendix or gall bladder might be the cause of a spasm of the right ureter pathological ovary or tubes the cause of spasm of the corresponding ureter and not uncommonly spasm of the ureter was found in the region of the brim of the pelvis or between this part and the urinary bladder where one might readily understand thickening and

inelasticity of the pelvic cellular tissue after operations on, or inflammation of, the pelvic viscera. Figure 2 shows the pyelogram and Figure 3 the tracing in a patient who complained of pain referable to the right kidney. This patient was very tender in the right costovertebral angle. When the kidney pelvis was filled to capacity (3 cubic centimeters), she complained that the pain that she felt was



Fig. 4. Pyelogram showing sluggishly contracting small pelvis, distended capacity 6 cubic centimeters. Cholecystography negative. Appendix removed some years ago. Has been well since taking quinine and eserine.

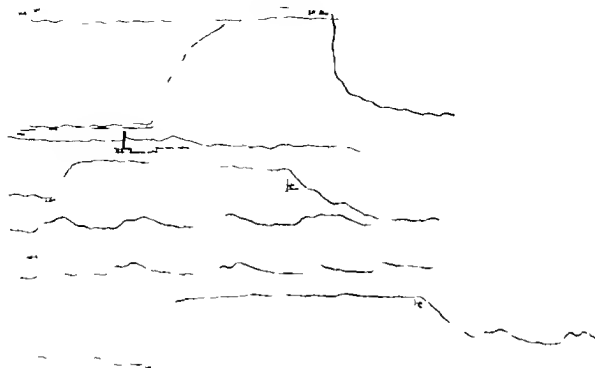


Fig 5

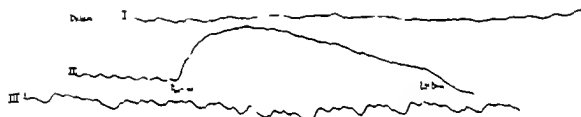


Fig 6

Fig 5 Appendectomy 15 years ago. Patient has complained of pain in right loin for 4 years. Sluggishly contracting small pelvis, distended capacity 6 cubic centimeters. Vomited bile stained fluid immediately after filling pelvis. Cholecystography negative (see also Fig. 4)

Fig 6 Sluggishly contracting pelvis with very slow movement of globule down ureter. There is apparent spasm at about 10 centimeters from the kidney and occasional antiperistalsis along the ureter. The kidney is ptosed.

what she usually felt, and she vomited green bile. The pyelogram also shows a large calculus in the gall bladder (confirmed by cholecystography). Cholecystectomy was performed and she has been quite free of her pain and "bilious attacks" since. Patients of this type with spasm of the pelvis of the right kidney also almost invariably vomit when the kidney pelvis is rapidly filled (for example when the contrast fluid is injected for the taking of the pyelogram) and the vomitus is generally bile stained, an indication of exces-

sive regurgitation of bile into the stomach and of antiperistalsis in this viscus. These patients will often volunteer the information that when the pain for which they are seeking relief comes on they vomit. This vomiting reflex is not an uncommon symptom of spasm in any hollow viscus unable to expel its contents, such as gall bladder or appendix. When the condition is on the right side and is associated with a diseased gall bladder the pain disappears after cholecystectomy. In cases in which spasm is not apparently associated with

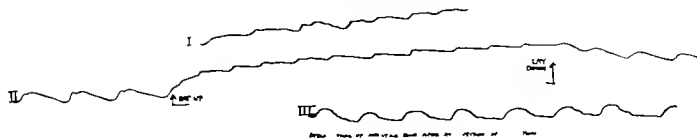


Fig 7

No. 14

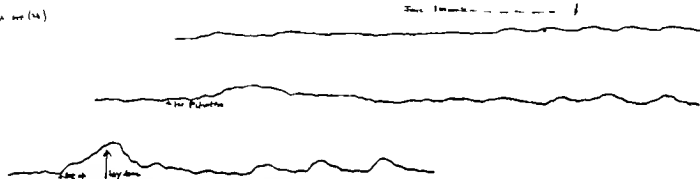


Fig 8.

Fig 7. Sluggishly contracting calyces and as each calyx contracts it empties through dilated communicating channel direct through pelvis into ureter.

Fig 8. Actively contracting slight hydronephrosis 16 cubic centimeters fluid injected into pelvis without pain. Catheter held up about 4 centimeters from kidney by kink

in ureter above which ureter was atonic. (Patient has large subinvolved uterus.) The dilated pelvis and ureter can be regarded as a failure of these parts to involute from the enlarged condition which is normally found in the presence of pregnancy to the normal non-pregnant size.

a diseased gall bladder as when a normal Graham's test is obtained the patients very often respond readily to such a drug as quinine and after a course of treatment for a few weeks often remain apparently cured but even in these cases one cannot help feeling that when no pathological condition in the urinary tract is demonstrable a pathological condition in a related viscus is the cause and should be sought for. This is illustrated in the pyelogram (Fig 4) and tracing (Fig 5).

Another interesting case is illustrated by the patient whose pyelogram (Fig 24) is shown.

This patient has had several attacks of hematuria and pain in the right loin. Radiological examination of the urinary tract was negative. The urine contained pus and blood cells. Pyeloscopy showed spasm of the kidney pelvis and upper ureter as far as the brim of the pelvis. Cholecystography was done and the report was "pathological gall bladder." At operation a diseased gall bladder containing several small stones and a diseased appendix were found. The gall bladder and appendix were removed and the patient has been well since. It is suggested that in this case the kidney pelvis was infected across the peritoneal

cavity from the infected gall bladder, thus accounting for the bacilluria and occasional hematuria.

In the present analysis an attempt will be made to present tracings and pyelograms illustrating most of the following pathological variations of the normal physiology of the kidney pelvis.

1 Normal tracing. Calyces and pelvis contract normally and globule passes normally down ureter, capacity of pelvis about 10 cubic centimeters (Fig 6 III, Fig 7 III).

2 Atony of pelvis. (a) Calyces and pelvis contract poorly when pelvis is filled, capacity about 15 to 25 cubic centimeters (Figs 8, 9, 10, 15, 21). (b) Calyces and pelvis contract well when only about 3 to 5 cubic centimeters of fluid is in pelvis. This is seen in tracing Figure 11 after patient has sat up, when kidney pelvis partly empties itself. When the pelvis is apparently quite empty (after the patient has sat up for some time) the contractions are shallower. In these cases the tracing shows very shallow waves due to poor

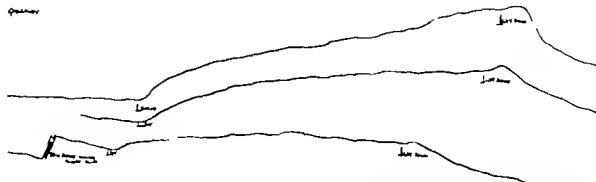


Fig. 9. Sluggishly contracting slight hydronephrosis (capacity of pelvis about 1.5 cubic centimeters). Some hold-up in ureter at hymen ("vagotonic" slow pulse 60 contracted pupils). Operation for retroverted uterus (Gillman operation) and chronic appendix (appendicectomy performed). Patient also had pilosed cecum, colon in pelvis, and spastic transverse colon.



Fig. 10. Pyelogram. Sluggishly contracting slight hydronephrosis. Capacity of pelvis .5 cubic centimeters (see also Fig. 9).

contractions. When the patient is made to sit up some of the fluid is expelled from the pelvis by the rise in intrapelvic pressure induced and the waves are increased in amplitude (see also Fig. 13 I and II). Fig. 13 III shows the effect of overfilling the kidney pelvis and Fig. 13 IV the improvement in rhythm (abolition of

antiperistalsis) by emptying of the kidney pelvis by sitting up and lying down several times. The tone of this class of pelvis can be improved by giving stimulating drugs such as eserine or strychnine in ordinary therapeutic doses over a period of one month or more, or an occasional injection of pituitrin (Fig. 8).

3. Spasm of the pelvis. Capacity of the pelvis about 3 to 5 cubic centimeters (1) without any apparent antiperistalsis in the ureter (2) with antiperistalsis in the ureter. Shallow waves are seen which are not improved as a rule by sitting up. However if the pelvis is overdistended the waves improve when patient sits up (Fig. 20 II). When antiperistalsis occurs these waves of antiperistalsis are superimposed on the waves of the calyceal and pelvic contractions and so an irregular series of waves is produced. Occasionally the sudden distention of a small pelvis apparently stimulates its musculature and an improved series of waves is obtained (Fig. 20 III, IV). The spasm in these cases can be relieved by giving quinine sulphate or hydrochloride say 5 grains three times a day. If the kidney pelvis is contracting too rapidly the condition can be relieved by aceto-salicylic acid.

4. Spasm in the ureter (1) without apparent antiperistalsis, (2) with antiperistalsis in the ureter—(a) up part of the ureter (b) up to pelvi ureteral junction (c) in to pelvis (see

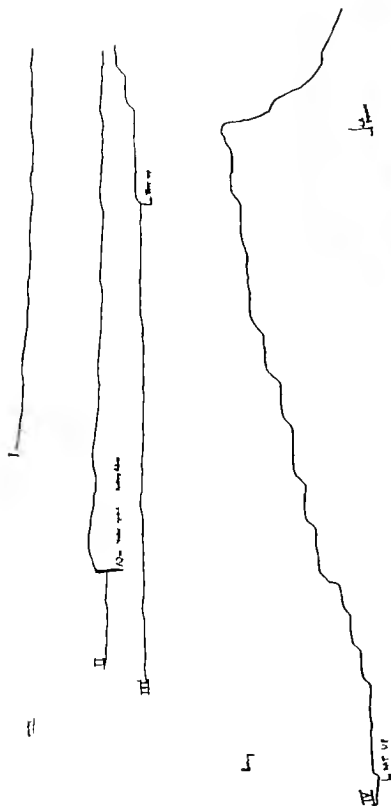


Fig 11



Fig 12

Fig 11 Sluggishly contracting dilated kidney pelvis (see also Fig. 12)
 Fig. 12 Pyelogram. Sluggishly contracting dilated kidney pelvis. In this case an intravenous pyelogram gave a very poor small shadow appearance due to unpaired excretory activity of the kidney (see also Fig. 11)

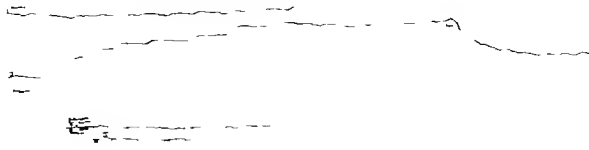


Fig 13

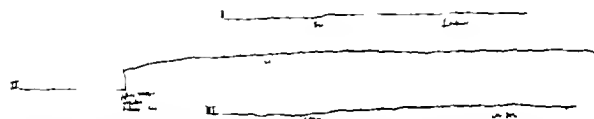


Fig 14

Fig 13. Stagnantly contracting aberti by hydronephrosis. Spasm in ureter at brim with antiperistalsis up to pelvi-ureteral junction. Appendicectomy. Relief.

Fig 14. Pyelocopy. Capacity of pelvis 4 cubic centimeters. Spasm of whole pelvis but relaxed upper long

communicating channel. Spasm in ureter at brim with antiperistalsis in ureter sometimes to upper calyx. Pyelogram shows filling of collecting tubules. Tracing 3 and 4.

Fig 15, III Fig 17 Fig 20) (d) in to a calyx (Fig 14).

If no antiperistalsis occurs the pressure in the pelvis steadily mounts until the waves of contraction pass through; if there is antiperistalsis arrhythmia is produced. In the latter case the pressure in the pelvis is low and there is very little rise in pressure when patient sits up. The pain in these cases is best relieved by an injection of pituitary extract, and with the restoration of normal function it is remarkable how long it will remain apparently normal—at any rate the patient feels well. One such case was illustrated in a previous paper (Jona 7).

5. Atony or dilatation of upper ureter. Greatly lowered resistance to outflow from kidney pelvis. Shallow waves shown with very small rise in intrapelvic pressure after patient sits up or lies down or after the injection of fluid into the kidney pelvis (Figs 22, 23). These patients are best relieved by giving eserine and in cases in which there is an

associated spasm of the kidney pelvis quinine is given with eserine.

6. Arrhythmia accompanied by pain. When the arrhythmia is abolished, tracing shows regular contractions and the patient's pain is relieved (Fig 6, III, Fig 25, Fig 26).

The patients, however, do not readily fall into one or other of these groups but one often finds combinations of the various groups and in cases one may find spasm in one part of the system and relaxation in another. Where some definite pathology of some related viscus can be determined it is easy enough to understand the basis of the dysfunction of the pelvi-ureteric musculature but in case no definite lesion is demonstrable search must be made for the cause in the kidney itself in some pathological condition in the urine such as phosphate or uric acid crystals, or in some disturbance of the pelvi-ureteral musculature itself or its nerve supply. In this latter regard the physiological information is rather vague. Many of these patients are of neurotic type.



Fig 15. Dilated right kidney pelvis with sluggishly contracting calyces and pelvis. Globule passed quickly down ureter (see also Fig. 16)

We know that in the dog (Starling) the kidney receives nerves from the fourth dorsal to the second lumbar segments via the sympathetic chain through the renal plexus. Many, if not most of these nerves are undoubtedly vasomotor but some must be efferents to the smooth muscle of the renal pelvis and the ureter. Whether some of these are also afferents has not to my knowledge been definitely determined and it would also be interesting to know definitely what happens to the branch of the vagus to the renal plexus described by anatomists (Cunningham 2) and whether this twig contains afferents or efferents or both. In regard to other viscera the gall bladder is supplied from the left vagus and solar plexus (Cunningham 3) the ovary from the tenth dorsal nerve the fallopian tubes from eleventh and twelfth dorsal and first lumbar segments (Cunningham 6) and the appendix from solar plexus and possibly also the vagus. The kidney however is apparently able to function and its musculature can carry out its function when all nerves have apparently been cut as has been done by various surgeons in the operation of so called renal sympathectomy. This fact is also demonstrable in the isolated kidney. One has also seen patients in whom a pathological gall bladder has been associated with dysfunction in the left kidney pelvis and the patient has had relief of her kidney pain after cholecystectomy. That marked reflex effects may be set up from the kidney is also well known and in the class of case referred to above where one finds by pyeloscopic spasm of the kidney this is common. In such a case in which the pelvis

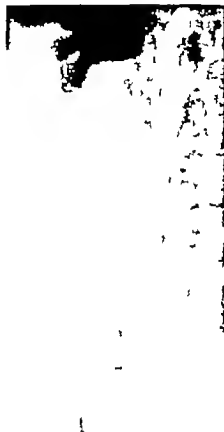


Fig 16. Pyelogram. Dilated kidney pelvis with sluggishly contracting calyces and "ventricle" (see also Fig. 15)

is rapidly filled the patient complains of great pain and often vomits (the vomitus often being bile stained) the pulse is slowed and the patient becomes pale and "knocked out." Such a case is illustrated in Figure 9. At operation this patient was found to possess a chronically inflamed appendix with a ptosed ascending colon and cæcum spastic transverse colon and retroverted uterus. She has been well since operation (removal of appendix and correction of retroversion) but whether kidney pelvis is like now the author cannot say because the patient declines further

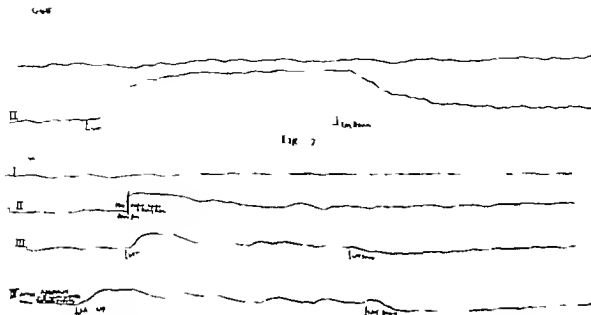


Fig. 7



Fig. 8. Pyelogram. Capacity of pelvis 4 cubic centimeters. Spasm at calyces and atony of communicating channels and filling of collecting tubules of kidney (see also Fig. 18).

18.

Fig. 9. Pelvis and calyces contracting regularly. Antiperistalsis in ureter from near brain back, lat. pelvis at irregular intervals with occasional stasis of globule in ureter.

Fig. 10. Capacity of pelvis 4 cubic centimeters, all calyces filled and contracting feebly. Globule in ureter passed down to 10 centimeters readily and held up in a section of ureter 10 to 15 centimeters from pelvis and again before antiperistalsis in these sections. Pyelogram shows small calyces and apparent atony of all communicating channels with filling of collecting tubules of kidney (see also Fig. 9).

investigation as she feels quite well. Another important aspect of the subject which must also determine our interpretation of the effects obtained is the apparent difference in the pictures sometimes obtained by intravenous and retrograde pyelography. Such a case is illustrated by Figure 12. The pyelogram obtained by intravenous pyelography shows an apparently normal sized and very poorly filled pelvis whereas by the retrograde method an obvious hydronephrosis with "rounding of the calyces" is demonstrated. The author thinks that in this case there was impaired excretion by the kidney (this is supported by the poor shadow in the intravenous pyelogram compared with the shadow of the opposite kidney) and that the patient's pain only came on under conditions when the outflow of urine from the kidney was impaired and the pelvis became distended.

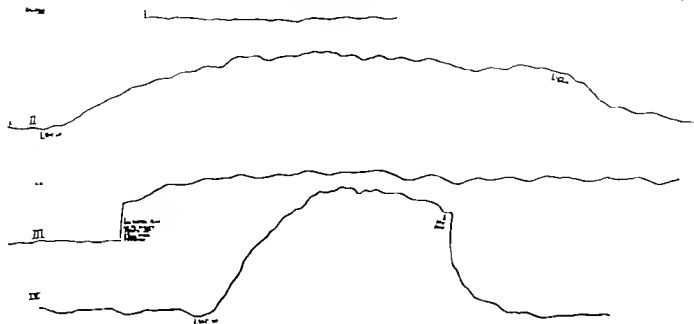


Fig 20

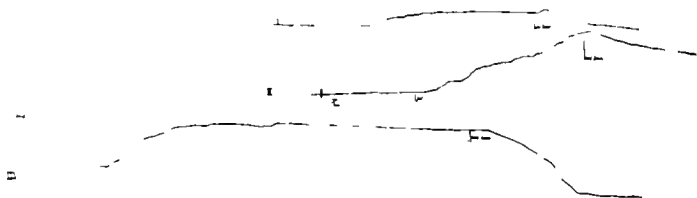


Fig 21

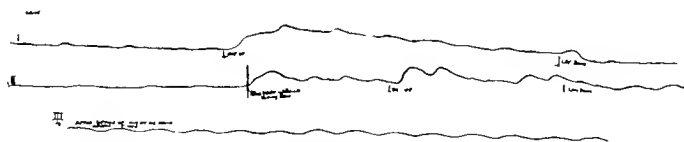


Fig 22

Fig 20 Capacity of pelvis 6 cubic centimeters. Spasm in pelvis. Poorly contracting calyces, spasm in ureter at brim with antiperistalsis up to pelvis and sometimes into ventricle.

Fig 21 Some atony of pelvis and upper ureter. "Terribil" apparently ran down ureter as fast as it was run into the pelvis. Cholecystography "pathological gall bladder. Operation hydrops of gall bladder which contained 200 cubic centimeters "white bile." Numerous stones, 32

about 1 centimeter in diameter removed and also one impacted in cystic duct.

Fig 22. All calyces contracted well. Hold-up in ureter 5 centimeters from pelvis with some antiperistalsis in this section of the ureter but globule passed well down ureter and pelvis emptied readily. Capacity of pelvis 10 cubic centimeters. Slight dilatation of upper ureter as far as brim where spasm of ureter (? due to old retroperitoneal infection. Appendicectomy several years ago) (See Fig 23)



Fig. 23



Fig. 24

Fig. 23. Pyelogram. Capacity of pelvis to cubic centimeters. Slightly dilated upper ureter as if it is "lumen" where spasm of ureter due to old retroperitoneal infection (appendectomy several years ago). (See also Fig. 22.)

Fig. 24. Pyelogram. Patient had recurrent hematuria and bacilluria. Spasm of kidneys pelvis and of ureter at the bend, with antiperistalsis. All bladder contained stones. Appendix pathological.

The occurrence of antiperistalsis in the ureter was so frequent that one wonders whether this may not be a pathological exaggeration of a normal occurrence—that is to say, that under certain normal conditions antiperistalsis does occur and that under certain pathological conditions it is exaggerated. I do know that antiperistalsis is a normal condition in the colon and facilitates the absorption

of water with antiperistalsis in the same back work in kidney and in the tubule in the same way.

the bowel. May not stasis of the kidney duct system combine a physiologic tubule system of absorption of fluid and that antiperistalsis commonly as full as the pyelogram.

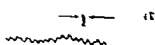


Fig. 25 Irregular contour



Fig 16. Irregular contraction Regular after patulin

This point requires further investigation which will be much facilitated when it will be possible to observe the contractions of the kidney pelvis and the passage of the 'globule' down the ureter without the necessity for the introduction of a ureteric catheter which introduces a foreign (and sometimes disturbing) element into the investigation. There can be little doubt that the indwelling catheter must tend to induce spasm of the ureter but it is suggested that this only mirrors (perhaps to an exaggerated degree) what normally occurs in the patient.

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Fig. 23



Fig. 24

Fig. 23. Pyelogram. Capacity of pelvis 10 cubic centimeters. Slightly dilated upper ureter as far as brim where spasm of ureter due to old retroperitoneal infection (pyelodiverticulosis several years ago) (See also Fig. 22.)

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tion of water from the bowel. May not stasis with antiperistalsis in the kidney duct system in the same way determine a physiological back working in to the tubule system of the kidney and thus facilitate absorption of water in the tubules? It was found that antiperistalsis in the ureter is more commonly seen when the urinary bladder was full than when it was emptied prior to the pyeloscopy.



Fig. 25. Irregular contractions. Regular after pain.

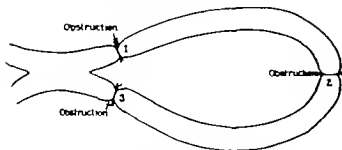


Fig. 1. A diagrammatic illustration of the method used in the preliminary experiments. A loop of intestine is joined by an anastomosis to short circuit the fecal stream. Obstruction at 1 gives a long segment distal to the obstruction in which the peristaltic wave is directed away from the blind end. Obstruction at point 2 gives equal sized proximal and distal loops. Obstruction at point 3 creates a long blind loop proximal to the point of block in which the peristaltic wave is toward the blind end. It is in this type that material is trapped in the blind loop.

RESULTS

In all 60 dogs were operated upon. Thirteen of these were discarded from consideration for various reasons. Two died of distemper, 2 died from acute intestinal obstruction 1 because of torsion of the mesentery and the other from herniation of bowel through a rent in the mesentery. Three developed peritonitis soon after operation. All had a leak in a suture line 1 at the anastomosis the 2 others from the invaginated end of the severed bowel. Six animals died from intussusception. These all occurred in the preliminary experiments in which inadequate care was exercised to suture or tie together firmly the two ends of the severed bowel. Intussusception never occurred in the proximal segment. To do so it would have to go against the direction of the peristaltic wave. Consequently in later experiments designed to study the effect of blind loops having the fecal stream carried into them, it was not necessary to guard against intussusception. But in cases in which the direction of the peristalsis is from the blind end toward the anastomosis intussusception will regularly occur unless prevented by fixation from suture or adhesions. In 7 animals loops up to 5 feet in length were joined by an anastomosis but were not obstructed. They were deaired for comparison with the obstructed loops. After many months they showed no significant alteration from the normal. One interesting fact was noted that the anastomosis often persisted. In one

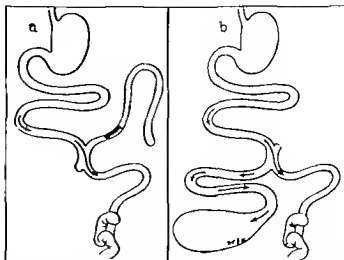


Fig. 2. a, A diagrammatic representation of a blind segment in which peristalsis empties the loop. In practice the two cut ends were tied together to prevent intussusception. b, Represents the opposite condition in which the material is carried into the blind loop by the direction of the peristaltic wave thus causing a trap for the accumulation of intestinal contents.

instance it was patent 1 year after operation. This observation is contrary to the conception that an abnormal opening in an unobstructed viscus will close.

The fate of blind loops distal to the obstruction. When the direction of the peristaltic current is away from the blind end and toward the anastomosis (Fig. 2, a) the segment of intestine remains empty. If any material gets into this portion of the bowel it is promptly removed. In 8 animals loops of 1, 2, 3 and 4 feet in length were created in the jejunum. The dogs were observed for 3 to 6 months. The appearance, activity, nutrition, appetite and bowel function of these animals was normal. The blind loop when examined at operation or postmortem was collapsed and empty. Both gross and microscopic examination of the intestinal wall showed no abnormality. It may be concluded that moderate sized blind loops below the obstruction are harmless. Peristalsis tends to empty the lumen since it is directed away from the blind end. This type of loop is a functionless segment of bowel.

The effect of blind loops proximal to the obstruction. When the direction of peristalsis is toward the blind end material is trapped in the loop of bowel (Fig. 2, b). It is carried in but can not get out. This results in the collection of intestinal contents with dilatation

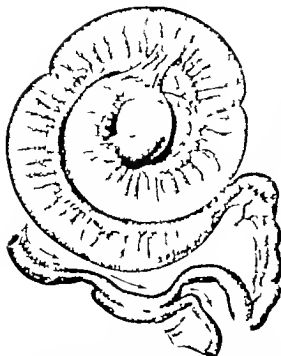


Fig 3 The size of a blind loop 60 days after its formation in comparison to the size of the normal intestine. Tremendous hypertrophy and dilatation has occurred.

of the intestine to form a veritable cesspool of the loop. It is a study of these animals that has been of the greatest interest in the present investigation.

There were 31 dogs with proximal blind loops that were suitable for study. In a consideration of the results these may best be grouped into those with short medium and long jejunal loops and those with an ileal segment.

Short jejunal loops Six dogs were studied with short blind loops in the upper jejunum.

Dog 31109 had a loop 6 inches long. During his period of observation of 16 months there were no signs or symptoms of abnormality. At autopsy the loop was small collapsed and empty. It measured only 4 inches in length. Dog 31232 had a 9 inch loop which caused no trouble. At the end of 15 months it was inspected and found to be 5 inches long collapsed and empty. Dog 31310 had a 12 inch loop which after 12 months presented the same result. Thus blind loops of 1 foot or less in length caused no harm to



Fig 4 Roentgenogram of a dilated blind loop. The arrows show powerful peristaltic waves driving the barium into the dilated end. Contrast the size of the blind loop, A with the normal intestine, B.

the animal. They apparently emptied themselves.

Three animals were observed with 2 foot blind jejunal loops. One of these lived for 8 months without evidence of abnormality. It was found on inspection that the loop was dilated and filled with a thick cheesy material. In the 2 others perforation of the bowel and peritonitis caused death in one instance in 42 days and in the other 154 days after operation. Both showed a large dilated blind loop filled with food and foreign material. The bowel had been ulcerated through by a piece of bone in one dog and perforated by a splinter in the other. Neither of these animals showed systemic change prior to the perforation.

Medium sized jejunal loops The animals which had medium sized blind loops were the most interesting of the series. There were 10 in all 6 with 3 foot loops and 4 with loops 4 feet in length.

Of the 6 with 3 foot loops, 1 died in 201 days from perforation of the bowel and peritonitis, 2 were sacrificed in 158 days and 247 days, respectively and 3 died in 148 174

and 201 days after operation from the effects of the blind loop. Of the 4 animals with 4 foot loops, 1 died in 170 days from perforation, 1 died in 102 days from the effect of the loop, and 2 became quite toxic but were saved from death by the resection of the loop on the one hundred and sixty-sixth and two hundred and twenty-first days respectively. Thus there were 6 dogs in this group which developed deleterious effects of the dilated blind loops. These animals all reacted alike. They were perfectly well for 2 to 4 months. The first sign was diminution in appetite. There would follow progressive weakness, lethargy, and loss of weight. The animal would appear thin, listless, and weak. The eyes would be sunken and dull as the emaciation became extreme. Often the animal was too weak to stand. There was never vomiting. Diarrhoea occurred only at infrequent intervals in a few instances but all had loud rumblings and borborygmi in the abdomen. Unless the loops were resected these animals died.

On examination the blind intestinal segment was so greatly enlarged (Fig. 3) that it often appeared to occupy most of the abdomen. There was progressive dilatation so that the diameter of the blind end was often three to four times that of the normal intestine. The length of the segment was invariably shortened from that at the original operation. The walls were greatly hypertrophied so that the muscular portion was thrice that of the normal bowel. There was an amazing amount of material in these blind loops. The intestinal contents varied from thin, putrid material to a thick cheesy substance. Interspersed in it were hair, bones, shivers of wood, glass, gravel, vegetable fiber, and seeds of many kinds. All this was churned together into a heterogeneous mass completely filling the lumen.

It is very instructive to watch these blind segments under the fluoroscope after they have been filled with barium. When the intestine is inactive the loop appears uniformly filled and the walls are smooth. Peristalsis, beginning near the anastomosis, sweeps down to the blind end. As the strength of the waves increases the incisura caused by them deepen until the lumen is nearly obliterated. The

barium is carried up to the blind end which becomes dilated (Fig. 4). The dilatation increases as wave on wave drives the material into this cul-de-sac. After a variable period of time the peristaltic action becomes feeble and finally ceases. With this the barium flows back through the loop, the dilated blind end resumes its former size, and the remainder of the segment fills. There is no evidence of reversed peristalsis in this process. It is a flowing motion apparently initiated by the elasticity of the dilated blind end. Some of the barium spills over through the anastomosis into the distal intestine. It is probable that this is the mechanism of removal of the more fluid contents of the blind loop and the explanation of the retention of the solid foreign substance. The latter cannot flow out as does the fluid. At the end of a week all the barium had been eliminated from the segment.

It has been noted that 6 of these dogs died after a period of anorexia, lethargy, and emaciation. It is presumed that death was due to the effect of the dilated blind loop. In order to prove this, however, it was thought necessary to demonstrate recovery from symptoms after excision of the loop. This was done in two instances. Since both were similar, the detailed recording of one will serve as an example.

Dog 32-249. A black and white long haired male of 50 pounds was operated upon December 9, 1932. A blind loop 4 feet long was made from a point 12 inches below the duodenojejunal junction. The continuity of the intestines was re-established by an isoperistaltic lateral anastomosis.

The animal had an uneventful convalescence with primary healing of the operative wound. He was perfectly well for over 3 months. In March of 1933 he began to lose his appetite. This progressed until in April he was taking less than half his daily ration. He became listless and lethargic. By the first of May solid food was refused and only water or milk in small amounts was taken. Weight loss had become marked and lethargy was increased so that he moved only occasionally.

On May 24 it was noted "the dog is thin, emaciated so weak that he can barely stand, and lethargic. His eyes are dull and sunken. There are skin ulcerations over the sternum and hips, despite a soft bed. There has been neither vomiting nor diarrhoea. The blood non-protein nitrogen is 31 milligrams per 100 cubic centimeters, the chlorides 552 milligrams per 100 cubic centimeters, the sugar 92 milligrams per 100 cubic centimeters, and the

carbon dioxide 50 volumes per centum. He now weighs 25 pounds, just half his former weight."

He was given 500 cubic centimeters of 5 per cent glucose intravenously on May 25 and 26. On this day under ether anesthesia the dilated blind loop was resected. After operation he was placed on a soft bed in a warm room. He made an uneventful recovery taking water and milk on the first 2 days after operation. He then took small amounts of solid food, table scraps mixed with salmon or liver. His appetite and intake increased, he gained weight and his energy returned. On August 17 he had regained his normal weight being 40 pounds 6 ounces. At this time he was occasionally taken out for a run. On these occasions he was energetic and active, skylarking about with exuberant spirits. If the walk was near good cover he would course back and forth looking for pheasants. He gave every indication of being a normal, healthy dog. Observation was continued for 6 weeks to make sure that recovery was complete.

This, and the other similar experiment (Dog 32 170) prove that the blind loop gave rise to a metabolic disturbance which is relieved by its excision.

Large jejunal blind loops. There were 11 experiments with long blind jejunal loops. Five were with loops 6 feet in length and 6 were 5 feet long. Of these 2 animals lived for a longer period than the rest of the group. Dog 31 168 with a 6 foot loop lived 70 days and Dog 32 124 with a 5 foot loop lived 81 days. These animals presented the characteristic changes of intoxication described in the 6 animals with shorter segments. The blind loops were greatly dilated thickened and filled with inspissated material when examined at autopsy.

On the other hand the 9 remaining dogs presented a sharply different picture. Soon after operation they had diarrhea, loss of appetite, loss of weight, dehydration and emaciation. They died in 5, 7, 10, 12, 14, 15 and 23 days after operation. At postmortem examination the loops were dilated with gas or fluid but were never markedly distended. It was thought that so much of the small intestine had been withdrawn from active use that these animals suffered from a lack of absorptive intestinal surface.

Blind loops in the terminal ileum. Five experiments were conducted upon blind loops of the terminal ileum. All were done with a 3 foot intestinal segment. Two animals died

from peritonitis due to perforation of the blind loop by a foreign body. The 3 other animals lived. They showed no deviation from the normal being well nourished, healthy and active. They were sacrificed at the expiration of 8 months. Examination showed the blind loop to be greatly dilated thickened and filled with debris. The latter consisted of solid foreign material there being little or no intestinal contents present. The behavior of these animals may be contrasted with those which had jejunal loops of the same size. These latter were accompanied by a chronic intoxication.

Gastro-intestinal ulceration. At the post mortem examination not only the blind loop but also the stomach and intestines were opened and examined. In the last 22 examinations a special search was made for gastroduodenal ulceration (5). In the entire series of experiments, only one ulcer was found in the upper gastro-intestinal tract. This was in an animal which had had a 3 foot blind loop of the terminal ileum for 49 days and died of peritonitis.

It has been noted that 6 animals died from peritonitis following perforation of the loop. In all instances the wall was ulcerated through but a foreign body was always in contact with the ulceration and usually protruded through the perforation. Other superficial ulcerations of the mucosa of these loops were occasionally noted but they in turn were in contact with a foreign body held by the debris in the lumen. These ulcerations of the blind loop were considered to be due to pressure necrosis of the foreign bodies in contact with the mucosa.

Blood chemistry changes. Determinations were usually made on the non-protein nitrogen, chlorides, carbon dioxide and hemoglobin. Occasionally sugar or blood volume determinations were added. In all 261 estimations were made upon animals with blind loops. All readings were within normal limits. This being true it is unnecessary to tabulate all the results. Those in one animal will serve as an example (Table I).

CLINICAL APPLICATION

About a year after this investigation was started, Estes and Holm reported 2 cases of

abdominal pain borborygmi diarrhoea and debility following entero-anastomosis for intestinal obstruction. These patients had to have the blind segment of intestine resected before recovery occurred. One was a case of obstruction of the ileum following an appendiceal abscess in which an ileocolostomy was done. Thirty two days later the blind intestine was found to have elongated from 3 to 7 feet in length and to have become dilated inflamed and ulcerated. In the other case following a resection of the ileum for obstruction a 4 inch blind end of intestine was left beyond an ileocolostomy to cover a raw surface. At the end of 69 days the blind segment had become greatly elongated and distended and filled the lower half of the abdominal cavity. It was drained by an ileo-ileostomy. Nearly a year later it was found to be fully 18 inches in length and 3 to 4 inches in diameter. The blind loop was resected. Holm subsequently reported his experimental findings separately. Pickhardt reports a case of right hemicolectomy with ileocolostomy where the blind pouch of ileum became elongated and dilated without causing symptoms. In the discussion of this case DeWitt Stetten mentioned an instance of perforation of such a blind loop and Whipple told of a patient who developed typical pellagra associated with a chronic intestinal stasis.

These serve as examples of what may happen when a blind intestinal loop is left below an entero-anastomosis. That such trouble does not invariably occur is shown by the many patients who recover without incident after internal drainage of intestinal obstruction by a short-circuit above the constriction. For several years it has been the custom in this clinic to use entero-anastomosis instead of enterostomy for drainage of obstructed bowel. In only one instance was it necessary to do a secondary operation after this procedure. Here the obstructed loop remained dilated so was resected.

H. M. No 3335 male aged 22 years, had had over a period of years, repeated attacks of colic associated with distention, visible peristalsis, and vomiting. He developed acute intestinal obstruction and was operated upon by Dr. J. J. Morton on February 22, 1920. The terminal ileum was bound down by a band which contained a pulsating artery.

TABLE 1—BLOOD CHEMISTRY DETERMINATIONS IN DOG 31316, BLACK AND WHITE FOX TERRIER, MALE

Date	N. P. H.	Chlorides	CO ₂ %	Hgb. %
9-28-1911	1	470	51	96
10-1-1911	28	483	48	90
10-16-1911	Operation—4 ft. blind jejunal loop			
10-18-1911	30	468	51	98
10-28-1911	34	400	58	100
11-1-1911	7	526	55	89
11-5-1911	30	453	50	89
11-15-1911	26	500	40	91
11-15-1911	Dog, though active, has begun to lose appetite			
11-18-1911	37	510	46	90
11-20-1911	27	555	50	90
11-23-1911	Moderate weight loss—still energetic			
11-29-1911	26	515	44	85
12-3-1911	26	535	44	91
12-23-1911	28	555	44	90
12-25-1911	Very thin, wasted, and lethargic			
12-29-1911	28	515	44	86
1-30-1912	Dead—Autopsy showed only a huge dilated blind loop filled with foreign debris and thick fluid			

Rather than cut this, the dilated and collapsed loops were joined by a lateral anastomosis. Recovery was uneventful. Two months later a roentgenographic study showed stasis of barium in the ileal loop for 72 hours. Six months after operation there occurred abdominal discomfort, anorexia, nausea and vomiting on three occasions, and loss of weight. On August 31, 1920 a 2 foot blind segment which was thick walled dilated, and ulcerated was resected the previous anastomosis being left intact. There was diarrhoea for 3 weeks after which the patient was symptom free.

It may be argued that the reason patients do not more often develop symptoms of blind loop stasis after entero-anastomosis is that the obstruction is spontaneously relieved. Thus adhesions may relax or resorb to allow the continuity of the tract to re-establish. But this is not invariably the explanation. In the following case the bowel was obstructed by recurrent carcinoma which obviously could not be expected to resorb.

H. R. No 30304. The patient, an engineer 48 years of age, was admitted to the hospital 6 months after the onset of symptoms of carcinoma of the rectum. The growth was fixed to the prostate and

seminal vesicles. The first stage of exploration and colostomy was done December 19, 1930. On January 4, 1930, a radical resection of the rectum, prostate, and seminal vesicles was done by Drs Morton and W W Scott. He was discharged February 3, 1930 in good condition. On May 13, 1930, he returned with symptoms of acute intestinal obstruction. Exploration at this time showed the lower ileum to be constricted to the point of obstruction by a ring of recurrent carcinoma in the pelvis. An ileocolostomy was done with recovery. There were no symptoms indicative of blind loop obstruction prior to death 3 months later.

The exact length of the blind loop in this case was not measured. It was long enough to reach from the obstruction in the pelvis to the lower ascending colon probably between 12 and 18 inches in length. If one assumes that all long blind intestinal loops cause gastro-intestinal derangement as the experiments would seem to show then it is on a basis of the shortness of the loop in this case that one must explain the freedom from trouble. Certainly the carcinomatous obstruction would be permanent. It has been shown in dogs that short blind loops of one foot or under in length neither dilate nor cause symptoms. Those of greater size do dilate and if longer than 2 feet cause derangement of gastro-intestinal function. It is felt that on these two factors of permanence of the obstruction and length of the blind loop depend the eventual outcome.

The remarkable case reported by Little, Zerfas, and Trusler in which 8 years after entero-anastomosis and 4 years after the onset of nutritional disturbance pernicious anemia developed suggested the need of blood studies in the experimental animals. The level of hemoglobin was found to be within normal limits in all instances. This may indicate that there is no effect or that the intestinal derangement was of too short a duration to produce the result. The problem of the relation of gastro-intestinal derangement to the development of anemia is an interesting one. The production of a less severe but more prolonged chronic intestinal stasis may offer one means of attack on this problem.

The animals with long loops of 5 or 6 feet died soon after operation from dehydration and inanition. Their reaction and appearance

were typical of animals suffering from lack of absorptive intestinal surface. Flint has studied this problem both experimentally and clinically. He concludes that the loss of from one-third to one half of the small intestine is tolerated. To lose the use of more than this results in death. The length of small intestine varies within wide limits in the dog. Our measurements show a total length of from 8 to 14 feet with an average of 11.2 feet. Owings, in using small dogs, found a variation of from 5 to 11 feet, with an average of 6.6 feet. Because of this variation in total intestinal length, a fixed length of blind loop will represent a variable percentage of the whole. Thus a 3 foot blind loop in a dog with a 5 foot small bowel and in one with a 14 foot intestine do not represent the same thing even though the size of the loop is identical. In the experiments now in progress the length of blind loop is being determined in terms of percentage of the whole length. This is felt to be a more accurate conception.

To me the intriguing part of this study is the effect of the medium sized blind loops. In those animals with 3 or 4 foot segments which developed nutritional disturbance, what caused the change? Obviously the derangement was due to the presence of the loop for its removal relieved the condition. But the behavior of the animals led one to feel that an intoxication had caused their gastro-intestinal derangement. There was no evidence of a mechanical disturbance as evidenced by vomiting or diarrhea. The first effect was loss of appetite. The animal looked sick, refused to eat, became lethargic, and finally extremely emaciated. It is probable that the latter was due in part to starvation for their food intake became extremely low. But the anorexia antedated the nutritional disturbance so that starvation alone will not explain the condition. Moreover the anorexia is preceded by several months of normal function. This suggests that the process of distention and accumulation of inspissated material must reach a critical level before deleterious effects are produced. But this is not invariably the case, for some greatly distended loops were observed that had caused no change in the animal's condition. In fact, it is amazing how

big some get and still remain asymptomatic. Consideration was given to the possible relation of ulceration of the mucosa being associated with the onset of intoxication. Ulceration does occur probably from necrosis by the pressure of foreign bodies. No exact correlation could be made, for the evidence on this point is insufficient. It is felt that further study of these animals with moderate sized blind loops is desirable. It is possible that by so doing more information may be obtained about the process of chronic intestinal stasis.

It is felt that the demonstration of the deleterious effects of blind intestinal loops in no way contra indicates the use of entero-anastomosis in acute intestinal obstruction. This procedure is used only when it is inadvisable or impossible to remove the cause of the obstruction. The only alternative to its use is enterostomy. This procedure is often spoken of as a life saving operation. It is occasionally a life taking one for some patients die from an enterostomy. Aside from the dehydration, demineralization and loss of normal secretion which follow from such externally draining fistulae there are other effects. The wound is messy often excoriated and painful. When the need for the enterostomy is past, one occasionally has to resort to resection and anastomosis to close it. This adds to an already prolonged convalescence. Thus it is that we feel that entero-anastomosis with internal drainage of the obstructed bowel is preferable. To know that in rare instances the blind loop may dilate and cause symptoms is to be forewarned. This knowledge creates an obligation on one to follow these patients for a sufficiently long time to determine the end result. If gastro-intestinal derangements occur then re-operation is indicated.

SUMMARY

1. When entero-anastomosis is used for internal drainage of intestinal obstruction blind segments of intestine are left between the anastomosis and the point of obstruction. A study on 60 dogs was made to determine the fate of these blind loops. The results were as follows.

2. That portion of bowel below the obstruction where the peristaltic action is directed

away from the blind end toward the anastomosis remains empty. It is a functionless segment of intestine.

3. In the segment above the obstruction where the peristaltic current is from the anastomosis toward the blind end, material is carried into and retained in the blind segment. These proximal blind loops may be subdivided according to their length.

a. Short loops of one foot or less apparently empty themselves and so do not become dilated.

b. If the blind segment is 2 feet long it becomes dilated and filled with inspissated material. Observations for over a year have revealed that unless perforation occurs, no symptoms are caused by these dilated loops.

c. Proximal blind loops from 3 to 4 feet long become filled with inspissated intestinal contents, foreign bodies, and debris to the end that enormous hypertrophy and dilatation follow. If perforation does not occur, these blind loops, after a free interval of 3 to 4 months, cause a chronic intoxication. This is characterized by anorexia, lassitude and weakness which progress to marked lethargy, emaciation and finally death. During this syndrome there is no evidence of mechanical gastro-intestinal disturbance as shown by the absence of vomiting or diarrhoea. The blood non protein nitrogen, chlorides carbon dioxide combining power, sugar and haemoglobin show no significant deviation from the normal. Resection of the blind loop allows complete recovery of the animal.

d. Blind loops of 5 to 6 feet long subtract such a large part of the total intestinal length that a majority of the animals die from inanition and dehydration. This effect was ascribed to a lack of adequate absorptive surface.

4. Cases having gastro-intestinal derangements from blind loops are cited and discussed. A case of this type from our clinic is presented.

5. It is felt that the rare occurrence of nutritional disturbances from blind loops following entero-anastomosis does not constitute a contra indication to the operation. When release of the obstruction is inadvisable or impossible, internal drainage by entero-anastomosis is still considered preferable to external

drainage by an enterostomy. It is obligatory to follow all patients with an entero-anastomosis long enough to determine the end result.

I am indebted to Dr R B Raney, Dr J W Squibb, and Dr D N Beers for assistance with the experiments.

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THE EFFECTS OF CARBON DIOXIDE HYPERVENTILATION ON THE AERATION OF THE LUNGS IN PATIENTS AFTER OPERATION

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THE prevalence of postoperative pulmonary complications¹ is so well recognized it does not need emphasis here. In an attempt to find the cause of these complications numerous investigations have been made (5, 6, 10). Studies of postoperative pulmonary complications have been concerned chiefly with compilations of hospital records or investigations of the effects of laparotomy on the respiratory system. In earlier papers (1, 2) the writer recorded the results of more extensive measurements of these effects than had previously been made. It was shown that laparotomy produces certain profound changes in the respiration: (a) marked reduction in tidal air, (b) sharp increase in respiratory rate, (c) slight but not significant change in total ventilation, (d) rapid shallow type of respiration which sets up a vicious cycle tending to increase further the respiratory rate, (e) great reduction in complementary air, greater following upper than lower abdominal operations in both men and women, (f) great reduction in supplemental air, greater following upper than

lower abdominal operations in men but not in women, (g) about the same degree of crippling of the mechanism of forced inspiration and of forced expiration, (h) great reduction in vital capacity, the greater crippling in both sexes following upper abdominal operations and greater crippling in men than in women, (i) marked decrease in subtidal lung volume and in maximum lung volume.

These pulmonary changes as enumerated indicate severe injury of the respiratory function. The relation of this crippling to subsequent pathology has not been proved, how ever several methods of therapy have been designed to counteract the imperfect ventilation of the lungs indicated by the above data. Notable is the stimulation of respiration by carbon dioxide proposed by Henderson (7), a method which has been both praised (8, 11, 12) and severely criticized (3, 9, 13).

This paper is an attempt to determine whether the treatment of patients after operation with carbon dioxide inhalation has any effect in preventing or even diminishing the crippling of the respiratory system which occurs following laparotomy.

Fifty cases were studied. Twenty-two patients received carbon dioxide treatment after laparotomy and 28 used as controls.

¹ In September 1933, Dr John H. Powers of Cooperstown, New York, wrote to me asking if I knew of any data on postoperative vital capacity measurements in patients who had received carbon dioxide treatment as prophylactic measure. Since I had such material, with courtesy, in my records, not only of vital capacity but also of tidal air, residual air, subtidal volume, and maximum lung volume, I have compiled it and herewith present it briefly.

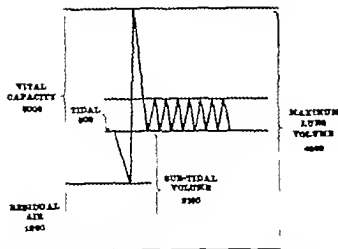


Fig. 1. A diagrammatic presentation of the factors concerned in this study. The numbers represent average volumes.

received no treatment. It is well known that pulmonary complications occur more frequently in men than in women. The ratio is usually expressed as 3 to 1, therefore it is important to have an equal distribution of sexes in the two series. Of the patients treated there are 8 men and 14 women; of the controls 10 men and 18 women. The ratios are the same. As nearly as it is possible to do so, the same types of operations are considered in both groups. Of the treated patients 11 underwent upper abdominal laparotomies, and 11 lower abdominal operations or herniorrhaphies, while in the control group 11

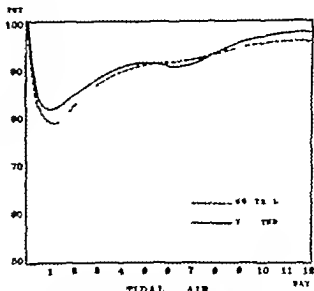


Fig. 3. Abscissa = days after operation. Ordinate = postoperative percentage of pre-operative values.

submitted to upper abdominal operations and 17 to lower. The cases investigated here are the same as those studied in relation to pulmonary complications by King (9). The postoperative carbon dioxide therapy has been described by him. Briefly, it consisted in a postoperative routine of treatment lasting for 3 or more days, starting after the patient had been returned to the ward. The carbon dioxide was administered by a full time graduate nurse. In all cases each treatment produced marked hypernara and was continued as

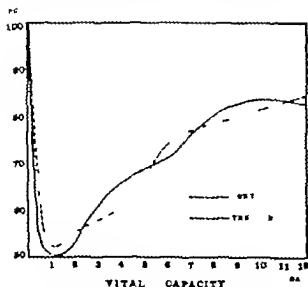


Fig. 3. Abscissa = days after operation. Ordinate = postoperative percentage of pre-operative values.

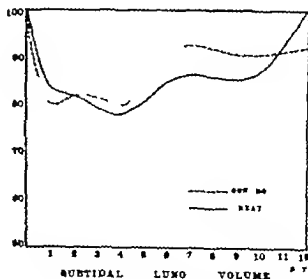


Fig. 4. Abscissa = days after operation. Ordinate = postoperative percentage of pre-operative values.

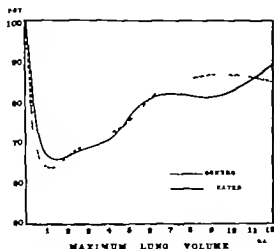


Fig 5 Abscissa—days after operation.
Ordinate—postoperative percentage of pre-operative values

long as the individual could endure it. Half the patients were treated by a method which consisted in having them rebreathe their own carbon dioxide through an 8-foot tube three times daily. Here the limit of tolerance was 2 to 3 minutes for each treatment. The second half of the group was treated more intensively. These patients received carbon dioxide from a tank through a face funnel 5 to 8 times daily. When they were treated in this way violent hypernea was attained more slowly; they could endure the treatment from 5 to 10 minutes. The data on vital capacity (see below) were studied to determine if it were affected by degree of treatment. No significant difference was observed between the cases in which the patients were treated 3 times daily and in those receiving more treatment.

The data on which this study is based were obtained by using a Benedict Roth spirometer (1) with rubber mouth piece, nose clip, recording pen and drum. A modified (2) Benedict Roth spirometer was employed to make the lung volume measurements according to the method of Christie (4). Ten per cent was considered to be the limit of experimental error. The factors considered here are shown diagrammatically in Figure 1.

Tidal air (average size breath). From an average of 20 equally spaced breaths over the 7 minute period

TABLE I

	Days after operation
First period	1
Second period	2
Fourth period	3-4
Sixth period	5, 6, 7
Ninth period	8, 9, 10
Twelfth period	11, 12, 13, 14

Vital capacity. Volume of a maximal expiration made following a maximal inspiration.

Subtidal volume. The volume of air remaining in the lungs at the end of a normal expiration (i.e. the volume of the lungs at rest).

Maximum lung volume. The volume of the lungs at the end of a maximal inspiration (vital capacity plus the volume of the absolute residual air).

The pulmonary volumes were corrected to 0 degrees C and 760 millimeters mercury pressure. These data have been graphed. In order to simplify the curves, the data were combined in the following manner: all values obtained on the first day for a given curve were averaged; likewise, those obtained on the second, on the third and fourth days; all values on the fifth, sixth and seventh days; on the eighth, ninth and tenth days; and finally on the eleventh, twelfth, thirteenth, and fourteenth days. This is shown simply in Table I.

Since analyses of the respiration were made more frequently during the first 5 days after operation and less frequently thereafter, this grouping of periods gives more nearly equal weight to each point than if the average value were plotted each day. By this method each point on the curve represents an equal number of measurements. Every determination has been recalculated in terms of percentage of pre-operative value. The values determined before operation were arbitrarily rated 100 per cent. The graphs demonstrate percentage changes; the ordinates represent post-operative percentage of pre-operative values; the abscissae represent the days after operation (Figs. 2, 3, 4, and 5).

In every case there is close relation of the treated and control curves. In no case has the divergence of the two curves exceeded the limit of experimental error.

SUMMARY AND CONCLUSION

It has previously been shown that laparotomy produces marked crippling of the respiratory system. Intermittent postoperative hyperventilation of the lungs caused by breathing a carbon dioxide rich air mixture has been employed as a means of reducing the damage. A "treated" group of patients was compared with a "control" group.

In the cases studied, carbon dioxide therapy following laparotomy had no effect in preventing the crippling of the respiratory system.

The writer wishes to acknowledge his great indebtedness to Dr. Donald King for the use of his records.

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ACUTE APPENDICITIS

A STUDY OF THE CORRELATION BETWEEN THE TIME OF OPERATION THE PATHOLOGY AND THE MORTALITY

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IN reviewing ten recently published articles (1 to 10) on acute appendicitis, I find a total of 16,424 cases reported with 894 deaths, a mortality of 5.5 per cent. The lowest mortality was 3.5 per cent in a series of 600 cases and the highest 6.5 per cent in a series of 900 cases. Twenty years ago (11) I analyzed another series of ten articles comprising 4,343 cases with 279 deaths or 6.2 per cent mortality.

Until the general mortality from this disease is very decidedly reduced from the death rates here shown it must remain worth our while to review accumulated experiences from all possible viewpoints.

For the past 26 years I have been analyzing and reanalyzing not only my own cases but those reported in the literature in an attempt to formulate some of the basic truths concerning the pathology and treatment of this disease. Without going into statistical details at this time I wish to emphasize two fundamental truths which I believe can be confirmed by any surgeon who will take the trouble to study his cases with reference thereto.

1. The operative mortality of acute appendicitis bears a definite relationship to the duration of the acute inflammatory process prior to the time of operation and for practical purposes the duration can be measured in terms of the day of the disease on which the patient is operated upon. The time of onset of the acute attack can almost always be accurately ascertained for there is seldom any doubt in the patient's mind as to the very hour when the acute attack commenced.

In cases in which operation is done during the first 24 hours of the attack the mortality in experienced hands, is almost negligible about 1 per cent. In cases in which operation is done during the first half of the second day of the disease the average mortality is from 2 to 3 per cent. After about 40 hours the

rate tends to rise sharply so that in cases in which operation is done on the third day of the attack the operative mortality averages about 10 per cent. Generally speaking fourth and fifth day operations are even more dangerous than third day operations. Beginning with the sixth day the operative mortality starts to decline and by the ninth or tenth day it again corresponds approximately with second day cases.¹

The gross operative mortalities given for the third, fourth and fifth day cases do not tell the whole truth concerning the mortality of operations performed at this period of the disease because by this time the mild cases destined to have little or no peritoneal involvement are clinically sharply defined from the cases with peritonitis and the mortality is confined very largely to those cases in which clinical evidence of peritonitis is presented at the time of operation. Thus, the mortality in cases with peritonitis in which operation is done at this period of the attack is much higher than shown by the combined figures.

The facts mentioned concerning the relation of the time element to the mortality of acute appendicitis have been recognized for many years but they will bear reiterating because today just as 30 or 40 years ago the

¹ I wish to back up the general accuracy of the statements contained in this paragraph relating to the mortality rates in relation to the time element. I have re-measured some recently reported data with the following results:

	Cases	Deaths	Death rate per cent
Operated upon first day of attack	297	10	3.4
Operated upon second day of attack	9	11	6
Operated upon third day of attack	661	26	3.9
Operated upon fourth day of attack	256	45	9
Operated upon fifth day of attack	447	49	8
Operated upon sixth day of attack	226	29	12.4
Operated upon 7th, 8th, and 9th days of attack	78	3	3
Operated upon 10th day of attack and later	299	7	2.4

problem of reducing the mortality centers very largely around those patients seen too late for an early safe operation and too early for a safe late operation. Of course the ideal solution would be to have all patients come to operation during the first 24 or 36 hours of the attack¹ but experience has apparently demonstrated that as long as human nature and human judgment remain what they are surgeons will continue to be called upon to treat a considerable number of late cases of appendicitis.

The second basic point which I wish to emphasize is the fact that the mortality rate as observed from day to day in this disease is inseparably associated with a corresponding sequence of changes in the inflammatory process itself. It is perfectly true that some appendices suffer vastly more initial damage than do others. Also it is true that the extent of peritoneal involvement at any given period varies widely in different cases. Nevertheless acute appendicitis is an acute inflammatory process and this process progresses from day to day through a definite and orderly series of changes in both the appendix and the complicating peritoneal lesion. While it is technically possible to remove the appendix during all stages of the disease experience has very definitely shown that the amenability of the peritoneal lesion to operative methods of treatment varies as the character of the lesion changes. In much of the literature the fluid exudates found on the first day are classed as diffuse peritonitis. Likewise the localized fluid collections are described as localized abscesses. This has led to a good deal of statistical confusion when these early lesions accompanied by an almost negligible operative mortality have been classified along with third and fourth day lesions of somewhat similar extent of peritoneal involvement the fact being ignored that the older peritoneal lesions are associated with an operative mortality many times that of the earlier lesions. Actually there is very little resemblance his-

tologically between the peritoneal lesions encountered during the first day of the attack and the peritoneal lesions of the third and subsequent days. According to my observations, the increased operative mortality of the later periods is as closely related to the character of the lesion as it is to the extent of the lesion.

About 30 per cent of the patients operated upon during the first day of the disease present noteworthy peritoneal exudates but, be the exudate fibrinous or fluid and regardless of its extent the peritoneal surfaces are not yet seriously damaged and, if further contamination from the grossly infected appendix is prevented by removal of the appendix experience has shown that the peritoneal surfaces are in the vast majority of cases amply able to take care of any infection present. It is probably worse than useless to attempt drainage in these early cases first, because it is unnecessary and, second, because the foreign body acts as a handicap rather than an aid to the natural processes of repair.

During the second day of the disease approximately 40 per cent of patients operated upon present noteworthy peritoneal lesions. The percentage of cases presenting peritoneal lesions has increased and the histological characteristics, especially at some distance from the appendix may vary considerably because not all peritoneal areas are involved at the same time—but generally speaking the peritoneal lesion in the immediate neighborhood of the appendix has reached the stage of capillary engorgement and marked leucocytic infiltration with beginning roughening of the peritoneal surfaces. Notwithstanding the much more formidable pathology encountered in patients operated upon on the second day of the disease experience has shown that in the great majority of cases the peritoneum is still able to take care of whatever infection there may be after the appendix is removed.

Both clinical and experimental evidences seem to show very conclusively that the second day peritoneal lesions are essentially undrainable. Certainly experience has shown that the great majority of these patients do just as well or probably better without drain-

¹Four series of cases studied by the writer show the percentage coming to operation during first 24 hours

	Per cent
1899 to 1905	0
1907 to 1911	4
1912 to 1915	4.5
1916 to 1919	56

age. Twenty years ago I attempted to use drainage in most of these cases but during the past 10 years in cases in which operation is done during the first and second days of the disease, except for a few patients operated upon after 40 hours, I have used drainage only in those cases in which I have had to open retroperitoneal spaces to dissect out gangrenous or grossly perforated appendices. I have never encountered any trouble attributable to letting the peritoneum fight its own fight at this stage uncomplicated by foreign bodies such as drains.

The proportion of patients operated upon on the third day of the disease who present noteworthy evidences of peritoneal involvement varies considerably in the experience of the individual operator. In general, it may be said that from 60 to 80 per cent of the cases referred to the surgeon at this period present definite evidences of peritoneal involvement but this high percentage represents in part a selection of cases because by the third day many patients destined to run a mild course have already demonstrated to the satisfaction of the family physician that they will probably recover from their present attack without the necessity of calling a surgeon. By the third day the operative mortality which began to climb in the cases in which operation was done during the latter half of the second day jumps suddenly to approximately 10 per cent for all cases in which operation is done during the third day. This increased mortality is confined not alone to cases in which the patient presents generalized free fluid in the peritoneal cavity but also to cases which present only local peritonitis and so called localized abscesses.

This latter point should be especially emphasized because the terrific mortality encountered from the third day on in cases in which operation is done for so called diffuse peritonitis has served to blind surgeons to the fact that in the aggregate a not inconsiderable number of the deaths following operations performed on the third, fourth and fifth days of the attack really occur in cases in which the patients presented rather localized lesions at the time of operation.

The sudden increase in the operative mortality noted in the third day of the disease is

coincident with a fundamental change in the histology of the peritoneal lesion. The intra-peritoneal exudate is now of a distinctly purulent character. The gross changes in the involved peritoneum especially in the immediate neighborhood of the appendix are very noticeable due in part to the more abundant fibrin and in part to the changes in the peritoneum incident to the beginning organization which seems in all cases first to become noticeable on the third day following the involvement of any given area of peritoneum. Limiting adhesions are now fairly well developed in most instances, but the lesions are, as yet, of a decidedly diffuse character the area involved being much more extensive than at a later period and there is as yet little or no evidence of the formation of sharply defined abscess cavities. It is at this time that pus is encountered extending irregularly between the various structures lying within the area of peritoneum involved.

The outstanding characteristic which distinguishes the third day peritoneal lesion is the presence of fibroblasts in the histological picture. Each square centimeter of involved peritoneum no longer has the histological characteristics and functional capacities of peritoneum because the involved surfaces have now taken on the characteristics of granulation tissue. This means that each unit area of peritoneal involvement has now begun to take on the histological characteristics of a true abscess cavity. Experience corroborates this concept because it is no longer possible to close these late cases without drainage. To accomplish operative cure purulent collections encountered at this period must be drained but the anatomical conditions encountered are usually such as to make efficient drainage difficult or impossible. In short the third day appendix case is very apt to present a highly infected peritoneal lesion in a patient who has not yet developed any considerable immunity to the infection and while the peritoneal lesion is such that efficient drainage is essential for success, the lesion encountered is of a diffuse multiloculated type which is technically almost impossible to drain.

The mortality in patients operated upon during the fourth and fifth days is in general

even higher than in third day cases and in many series has reached as high as 15 or more per cent. We are still dealing with a highly infected, essentially non-drainable peritoneal lesion. By the fourth or fifth days the process of organization is well established, the previously existing fibrous adhesions are being replaced by organizing granulation tissue which is also noticeable over the surfaces of the peritoneum in direct contact with purulent fluid exudates. This granulation tissue serves to encapsulate the pus and it is from this time on that the formation of definitely defined abscess cavities is observed, they being at first usually more or less multilocular but later becoming more localized to form, usually, one well defined cavity.

The decrease in operative mortality which begins about the sixth day and proceeds rapidly thereafter is coincident with, and undoubtedly bears a definite relationship to, readily observable clinical and pathological phenomena. It is not necessary to go into detail relative to the well known clinical phenomena such as the subsidence of the pulse rate and the drop in temperature which in severe cases usually reaches normal for the first time on the morning of the ninth day. Undoubtedly these phenomena signify the development of a relative immunity against the infection. This relative immunity is clinically demonstrable by the fact that from now on the sutured portions of appendectomy wounds seldom break down from infection whereas a large proportion of wounds made during the high temperature period of the attack do break down from infection.

The clinical features mentioned here have been emphasized by many writers but much of the recent literature has failed to emphasize the fact that purulent collections encountered after about the seventh day are contained in sharply defined abscess cavities readily drainable and in no way comparable to the ill defined, essentially undrainable intraperitoneal collections of fluid and pus encountered in the early and intermediate stages of the disease.

The number of patients presenting pus outside of the appendix shows practically no increase after the third day and except when there is a clinical history of a later acute

exacerbation of peritoneal symptoms, there is no evidence of an increase in the area of peritoneal involvement after this time. On the contrary, after the process of organization is well established, on the fourth or fifth days, there is every evidence of a progressive diminution in the extent of the peritoneal involvement, which becomes sharply localized and limited by the organizing adhesions.

This phase of the repair process which results in the more or less complete resolution of the peritoneal lesion beyond the immediate wall of an abscess, if present, is well shown in cases coming to operation on the tenth and eleventh days, the clinical picture having been on admission that of a severe diffuse peritonitis. In these cases the abscess cavities are often surrounded by a narrow zone of organizing adhesions, while the peritoneum of the ascending colon and nearby loops of small intestine beyond the wall of the abscess cavity, although non-adherent is thickened reddish, and distinctly granular without fibrin or other evidences of an acute lesion.

From July, 1907 to January 1, 1934, my associate Dr. C. W. Woodall and I have operated upon 1004 cases of acute appendicitis. Tables I, II and III summarize the results obtained in the three periods 1907 to 1914, 1915 to 1923 and 1924 to 1933.

Although pathological and clinical studies undertaken previous to 1907 had convinced me of the general advisability of deferred operations during the high mortality period of the disease, when I began operating upon patients referred to me by other physicians, I soon found that while it was technically easy and safe to carry out the Ochsner treatment on intermediate period cases with peritonitis, it was nevertheless morally very difficult not to operate upon most patients as soon as referred. This difficulty arose from the fact that when operation is postponed by the surgeon because a patient has not been referred until the case is 3 or 4 days old, the family physician may be at least in part responsible for some of the delay.

Between 1907 and 1914 (see Table I) I treated 116 cases of acute appendicitis with 6.9 per cent mortality. In approximately 58 per cent of these cases the patients had been

TABLE I—ANALYSIS OF 116 CASES OF ACUTE APPENDICITIS TREATED 1907-1914

	Treated	Percent of total	Dead
Acute diffuse or generalized—operated on during first 24 hours of attack	40	42	
Acute—with slight or no peritoneal symptoms—operated on after 48 hours	8	15	
Acute—with well marked peritonitis—operated on third to fifth day of attack	8	6.9	4
Patients seen after 48 hours with well marked peritonitis—Ochsner treatment—operated on later		9	
Mild cases—Ochsner treatment only		7	
Late cases with localized abscess at time of admission to hospital	6	3.2	
Rupture of old undiagnosed appendicitis abscess into general peritoneal cavity—Marked on admission		9	
	6	100.00	4 (3.5%)

referred to me 48 or more hours after the attack. Drastic cathartics, the immediate cause of most really dangerous complications in appendicitis, had been administered in a considerable number of cases. My results compared not unfavorably with currently reported series. Nevertheless, it was perfectly evident that one half of my total mortality had occurred in a group of 8 cases in which I had tried to extend the time limit for operation in severe cases into the third day of the attack or later. With possibly one exception none of the 8 patients immediately operated upon had appeared to be as ill as those included in the group of 22 cases with marked peritonitis in which treatment by the Ochsner method was used with only 2 deaths. As I studied these cases at the time it seemed perfectly obvious that at least 2 or 3 of the 8 deaths could have been avoided had I refused absolutely to operate during the intermediate stage of the disease.

Between 1915 and 1923 I treated 380 cases of acute appendicitis with 21 deaths, or 5.6 per cent mortality. Table II summarizes this series. One hundred and eighteen patients were operated on during the first day of the attack with 1 death. One hundred and twenty-eight were operated upon during the second day of the disease with 3 deaths.

Ninety three cases were referred for treatment between the third and sixth days of the

TABLE II—ANALYSIS OF 380 CASES OF ACUTE APPENDICITIS TREATED 1915-1923

	Treated	Percent of total	Dead
Acute diffuse or generalized—operated on during first 24 hours of attack	18	21	
Acute diffuse or generalized—operated on during second 24 hours of attack	25	23.6	3
Acute, with slight or no peritoneal symptoms—operated on after 48 hours	26		
Acute, with well marked peritonitis—operated on third to sixth day of attack	5	3.9	6
Patients seen after 48 hours with well marked peritonitis—Ochsner treatment	28	7.4	4
Mild cases, patients were let and treated by Ochsner and later operated on	4		
Late cases with localized abscess at time of admission to hospital	23	6	4
Rupture of old undiagnosed appendicitis abscess into general peritoneal cavity	6	5	3
	150	100.00	15 (5.5%)

attack. Fifty of these 93 cases appeared clinically to be mild cases with little evidence of peritonitis. Forty six were operated upon immediately and 4 were treated conservatively until temperature had subsided when operation was done. There were no deaths in this group of 50 late but mild cases.

Forty three of the late referred cases had definite evidences of more or less extensive peritonitis. Of these 28 were placed on the Ochsner treatment and later operated upon with 4 deaths. 15 were operated upon immediately with 6 deaths.

Were the two groups exactly comparable the difference between 4 deaths in 28 cases and 6 deaths in 15 cases would be suggestive but statistically of little significance. But as a matter of fact the two groups are not comparable because the clinically severe diffuse peritonitis patients were all treated by the Ochsner method whereas the 15 patients with peritoneal symptoms operated upon immediately were all of them at the time of operation thought to have relatively limited peritoneal involvement and therefore to be comparatively safe risks for immediate operation. A review of the individual histories left no doubt in my mind that at least 3 or 4 of these 6 deaths could have been avoided had operation been deferred in these cases.

There were 4 deaths among the 35 cases referred with localized abscess 7 or more days after onset of the attack. This is an unusually high death rate for this class of case but analysis of individual cases shows that 3 of the deaths were due to unavoidable accidents and complications.

In the period 1924 to 1933 we have treated 508 cases of acute appendicitis with 11 deaths, or a mortality rate of only 2.16 per cent. This is less than one-third the mortality of the 1907-1914 series and considerably less than one-half the death rate of the 1915-1923 series. A glance at Tables I, II, and III will show that this reduction is due to two chief factors. First a larger number of cases operated upon early—42.2 per cent in the first series, 64.6 per cent in the second series, and 79.6 per cent in the third series, and second a reduction by more than half in the mortality in cases seen during the late high mortality period of the disease. As a matter of fact from a purely statistical viewpoint the reduction from the 5.8 per cent combined mortality of the first 495 cases to the 2.16 per cent mortality of the last 508 cases is approximately half attributable to a larger proportion of cases seen early and the other half attributable to the 60 per cent reduction in the mortality of cases first seen during the high mortality period of the disease.

Combining Tables I, II, and III we find that in the entire series of 1,004 acute cases 20 deaths or one-half of the total occurred in the 113 cases admitted with well marked evidences of peritonitis during the high mortality period of the disease. Of these 113 cases, 31 were operated upon immediately with 13 deaths, a mortality of 42 per cent. Eighty-two were treated conservatively until the acute symptoms had subsided and later were operated upon with 7 deaths or a mortality of only 8.5 per cent.

Clinically the two groups were not strictly comparable at the time of admission because the cases operated upon immediately were none of them considered to be particularly bad operative risks at the time while the more desperately ill cases were not operated upon and therefore are included in the group of 82 cases with deferred operations. Had the 31

TABLE III—ANALYSIS OF 508 CASES OF ACUTE APPENDICITIS TREATED 1924-1933

	Treated	Per cent of total	Dead
Acute diffuse or gangrenous—operated on during first 24 hours of attack	270	53.0	1
Acute diffuse or gangrenous—operated on during second 24 hours of attack	125	24.6	5
Acute, with slight or no peritoneal symptoms—operated on after 24 hrs.	84	16.5	0
Acute cases with well marked peritonitis, patients operated on third to sixth day of attack	8	1.6	3
Cases seen after 48 hours with well marked peritonitis—Ochsner treatment	12	2.4	1
Mild cases seen third day or later and operation deferred—operated on no interval cases	18	3.5	0
Late cases with localized abscess (size of a dime) to hospital	20	4.0	1
Response of old unchanged appendix to abscess into general peritoneal cavity	5	1.0	2
	508	100.00	(16%)11

immediately operated upon cases been treated as were the 82 with deferred operations I feel reasonably certain that the mortality rate in this group would have been at least as low as was the mortality in the group treated by the Ochsner method. Had this been the case, it would have meant 10 deaths less and resulted in a 25 per cent reduction in the total mortality for the series.

In conclusion let me state that while the factual data reported in this paper are based on a series of only 1,004 cases studied in detail by me personally I have analyzed and combined the data presented in a large number of articles on acute appendicitis appearing in the domestic and foreign literature during the past 30 years and nowhere have I been able to find any definite factual data which seem to lead to conclusions definitely opposed to those I have expressed. On the contrary most of the data which have been presented in such form as to allow re-analyzing along the lines here set forth do I believe tend to confirm the conclusions emphasized in this paper.

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THE LIPID COMPOSITION OF WHITE BLOOD CELLS IN WOMEN DURING PREGNANCY LACTATION AND THE PUERPERIUM

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THE lipid composition of white blood cells in normal non menstruating non pregnant women has been reported in a previous communication (5) in which it was shown that the leucocytes lay midway between blood plasma and the active body tissues in respect to their fat content. The outstanding characteristic in the fat analysis of these cells was shown to be the relatively high percentage of phospholipid a finding which corroborated earlier findings of large amounts of phospholipid in the blood leucocytes of dogs (3). In addition however neutral fat and free cholesterol were present in amounts greater than those commonly found in blood plasma while cholesterol ester constituted a lower percentage of the total cholesterol than in plasma but higher than in most body tissues. There was also noted a wide variation in the lipid values which suggested that the leucocytes might well be found to exhibit an altered fatty composition in response to altered demands of body metabolism. During the course of an investigation into the nature of pregnancy lipemia (6) an opportunity was afforded to study simultaneously the fat content of the white blood corpuscles at the termination of pregnancy and during the puerperium and the results are reported below.

A review of the literature revealed that there exists a very meager knowledge concerning the metabolism of the white blood cells. Their basal metabolism has been investigated by Fujita who found using the Warburg technique, that the basal metabolism of these cells was analogous to that of embryonic cells but distinct from carcinomatous cells. Re-

garding their carbohydrate metabolism Stockinger and Freese noted that as sugar disappeared from the blood and lactic acid accumulated during fevers there were fewer granulations in the white cells which suggested to them that these histological particles may be organs for sugar storage. Fleischmann (15) was able to demonstrate that the respiration and permeability of horse leucocytes are affected by mineral salts particularly the alkali cations and halide anions.

A number of enzymes have also been found present in the white blood cells. Stern's results suggest the presence of a catalase which is similar in nature to this ferment in the liver and red blood cells. In horse leucocytes, Willstaetter and Rohdewald have shown there occur amylase maltase and trypsin. In 1910, Fleasinger and Marie presented a treatise on the facts then known concerning the proteolytic and lipolytic ferments of the leucocytes. Reich in 1915 postulated that the lipase was derived chiefly from the lymphocytes but Nees, by plating pus on fatty media, later found that fat was split by polymorphonuclear cells as well as lymphocytes. While these results are open to the criticism of bacterial contamination Fleischmann (14) has recently demonstrated by the improved Rona-Lasniks manometric technique the presence of lipase in the leucocytes obtained from sterile peritoneal fluid of rabbits.

Concerning the metabolism of fats attacked by this lipolytic ferment little is known. Histological methods, lipoid and fat stains being used constituted the earliest means of investigation and have, indeed been used

well into the present decade. Ciaccio in 1900 noted lipid inclusions microscopically in the large mononuclears amphophile, neutrophile and eosinophile cells these masses being relatively larger in size during infection and intoxication. With cresol blue as a selective stain, Hammar in 1913 perceived the presence of lipid granules in the leucocytes, the particles becoming more evident during autolysis of the cells. Savini in 1921 described the presence of lipid granules by means of Sharlach R and similar stains in granular and non granular leucocytes. Sehrt (31) in 1927 noted a relation between oxidase activity and the white cell lipoids and prepared a monograph (32) on the subject while Goldmann demonstrated in 1929 that the granules which stain with Sudan III are morphologically identical with those which exhibit the oxidase and peroxidase reactions. There appears, therefore, to be a close relationship between the lipoids of the white blood cells and their rate of oxidation and respiration.

Methods of a more strictly chemical nature have however been used to investigate the lipid composition of the leucocytes simultaneously with the histological procedures as noted above. In 1910 Mancini obtained suggestive evidence relative to the lipid composition of the white blood cells by combustion analysis of the horse leucocytes before and after washing with alcohol, ether, or chloroform. He found a decrease in the percentage of phosphorus and sulphur following extraction with the fat solvents and postulated, on this evidence the presence of "sulphatides" and phosphatides in the white blood corpuscles. In 1913 Wacker and Hueck applied a direct lipid analysis to horse leucocytes and demonstrated that the dried cells contained 1.729 milligrams per cent free cholesterol and 40 milligrams per cent ester cholesterol. In 1931 Cheng investigated the fatty acids of the gelatinous bone marrow which contains large numbers of white blood cells and is the seat of origin for many of them and found the presence of oleic and highly unsaturated fatty acids such as arachidonic acid. Evidence of a similar nature was obtained by Epstein and Lorenz studying the fat chemistry of Niemann Pick disease in this condition the liver spleen and

reticulo-endothelial system generally are engorged with leucocytes and analysis of these organs revealed a marked increase in lecithin and free cholesterol. These data suggested that white blood cells contained large amounts of phospholipid and free cholesterol and smaller amounts of cholesterol ester. In the previous communications (3, 5) the author was able to verify this by direct lipid micro-analysis demonstrating the quantitative relationships of these lipids and the further presence in considerable quantity of neutral fat.

The connection between fat metabolism and the white blood cells has also been demonstrated in a different manner by studying the effect of injecting lipids on the white cell count and differential count. Twenty years ago Hamburger and de Haan found that while free fatty acids decreased the phagocytic activity of leucocytes soaps augmented this important function of the cells. In 1924 Okuneff showed that the lipoids and waxy substances of the tubercle bacillus produced a polymorphonuclear leucocytosis and a decrease or but slight increase in the lymphocyte count. Brandberg demonstrated that the ethyl esters of the fatty acids present in chaulmoogra oil which contains the interesting group of cyclic fatty acids notably hydnocarpic acid ($C_{15}H_{26}O_2$) and chaulmoogric acid ($C_{17}H_{30}O_2$) caused a pronounced lymphocytosis and a polymorphonuclear leucopenia. And finally Hirsch has shown that lecithin intravenously causes a polymorphonuclear leucocytosis. In spite of the inconclusive nature of much of this work, there appears a general element of similarity in the results. From these the generalization may be made that esters or soaps of fatty acids and lecithin which, in a sense may be regarded as an ester of the fatty acids, excite a lymphocytosis while cholesterol and the higher alcohols or waxes a polymorphonuclear leucocytosis.

Wherever there occurs a physiological or pathological variation in the metabolism of the white blood cells one may expect to find an altered fat content. It is the purpose of this series of investigations to record the nature and the extent of such changes in order to throw further light onto the metabolism of these important cells in pregnancy fever.

TABLE I.—THE LIPID COMPOSITION OF THE WHITE BLOOD CELLS IN PREGNANCY AT TERM, DURING LACTATION AND THE PUERPERIUM

The results are expressed in milligrams per 100 grams of cells

Case No.	Age	Parity	Days post-partum	Total lipid	Composition of total lipid					
					Total fatty acid	Neutral fat	Phospholipid	Cholesterol		
								Total	Ester	Free
	30			661	344	77	37	195	6	59
			1	8,174	3,055	136	1,008	436	90	337
			6	1,304	307	304	1,360	46	303	360
				1,006	613	58	407	16	30	56
				744	412	26	417	33	39	46
				864	351	136	409	56		36
			6	1,013	1,136	613	1,051	304		314
3	37			903	619	406	346	51		1
				1,077	307	433	491	84	18	63
			3	800	430	76	307	7		114
			10	67	377	640	644	363	8	447
4	3	3		683	333	7	634	75	13	106
5	37	8		371	376	617	401	173	8	148
			3	6,331	1,376	303	1,340	399	18	454
			7	1,806	1,301	751	1,050	316	41	358
6				1,030	307	169	136	149	26	
				13	819	380	713	443	8	161
			9	106	137	41	1,376	31	38	140
7	31	7		1,143	355	407	600	364	18	146
8	34			1,130	330	30	1,130	58	41	7
				1,477	313	407	713	130	33	96
			14	1,016	1,163	718	1,030	306		118
9	37			1,131	366		1,416	373	19	130
10	33			1,097	377	34	1,308	686	116	473
			7	513	743	663	1,390	337	300	37
			7	1,140	1,057	716	1,300	413	13	380
11	43			8,713	1,297	378	1,360	431	183	369
				1,000	1,430	793	1,300	347	75	97
			3	1,131	608	151	1,48	663	136	305
			7	1,368	713	300	640	360	148	110
			1	1,304	1,000	137	373	360	300	363

*The "0" days postpartum indicates the postpartum specimen as described in the text.

menstruation digestion etc. The present contribution is concerned with such observations during the termination of pregnancy and the puerperium in women

From the early months of pregnancy there occurs an increase in the number of white blood cells the 'physiologic leucocytosis of pregnancy' of Virchow which may reach 15,000 (10) or 20,000 (1). The increase occurs not only in the polymorphonuclear leucocytes but also in the immature myelocytes indicating the rapid production of new leucocytes by the bone marrow. The increase is more marked in primiparae and is considered by Dietrich due to the intoxication resulting from pregnancy. During labor and the first day postpartum there is a further marked leucocytosis, the white cell count then falling gradually to normal intercepted only by a slight rise three to four days postpartum which coincides with the onset of lactation. The fat metabolism of white blood cells has been investigated, as reported below during these states by analysis of the lipid content (a) at the termination of pregnancy (b) during the first day or two postpartum (c) during lactation and (d) in the later puerperium.

METHODS

The general principles in the selection and care of patients utilized for experimental study conformed to the standard laid down in a former paper on the study of non-pregnant women (4). The subjects were chosen from the prenatal clinics of the Strong Memorial Hospital, referred in to the obstetrical divisions a few days before the expected date of confinement where they were thoroughly examined to exclude conditions other than pregnancy which are known to affect the level of blood lipids and then placed on a standard balanced diet and kept in bed for about a week before an analysis was made of their white blood cells. A sample of blood was taken before delivery and after parturition at various times as indicated in Table I.

Blood was drawn from the arm veins in the morning following a 15 to 16 hour fast, clotted and immediately centrifuged. In many cases it was possible then to remove the white cell layer with a pair of clean forceps, after the plasma was drawn off but in other cases the leucocytes were non adherent and a different procedure was adopted. The white cells, with the immediately adjacent layers of red cells and

plasma were transferred with a pipette to a small centrifuge tube and again centrifuged. It was then possible to draw off the wider layer of semi fluid leucocytes with a small pipette. Fifty cubic centimeters of blood gave sufficient white cells for a complete lipid analysis.

Following separation of the leucocytes, they were quickly weighed (wet weight), ground up with cleaned sand, and extracted with alcohol ether after the manner previously reported (Boyd 5). The extracts, made up to a volume of 100 cubic centimeters, were analyzed for their total fatty acid phospholipid total cholesterol, and free cholesterol by the oxidative micro-analysis procedure described in detail in a former paper (4). The remaining lipid values total lipid neutral fat, ester cholesterol, and the various component fatty acids were arrived at by calculation (4).

Since writing the original paper on methods (4) two papers have appeared by other authors (23-26) in which the oxidative digitonin micro-method for cholesterol has been criticized and alternative methods proposed. The gravimetric modification as proposed by Man and Peters appears to offer no advantage as in one case impurities are weighed while in the other they are oxidized. Oberman and Milton (26) also cite this objection viz. that extraneous matter in the digitonin precipitate may be included in the final oxidation and in addition state the oxidative procedure itself is uncertain. The first of these objections to the original method has been overcome by introducing a careful washing of the digitonin precipitate with water acetone, and ether whereas the second objection has also been removed by determining and using the procedure necessary for 100 per cent oxidation of the cholesterol digitonide which is considerably more resistant to oxidation than phospholipid or fatty acid (4). In the experience of the author the most vulnerable step in the whole method for total cholesterol as herein used is the saponification procedure. Unless the directions as previously reported (4) are strictly followed and if the hydrolyzing mixture is concentrated below a volume of a cubic centimeters cholesterol becomes so altered that it is rendered only partially precipitable with digitonin. Oberman and Milton (26) noted these dangers during

saponification and state that in the presence of acid digitonin precipitation is incomplete. Hence they do not acidify their mixture after saponification but extract directly from the alkaline medium with petroleum ether.

EXPERIMENTAL RESULTS

From an analysis of the lipid content in the white blood cells of 11 cases of pregnancy at term (Table I) no general trends from the non pregnant levels as previously reported (5), could be deduced. On the average, the fat content of the leucocytes was reduced in pregnancy by one quarter the decrease being most marked in neutral fat and cholesterol ester each of which was lowered 50 per cent on the average, from the non pregnant levels. Free cholesterol and phospholipid showed little variation. It is doubtful, however if a comparison of mean values in this connection has much significance. Practically all the values noted in pregnancy fell within or very close to the range of levels for the non pregnant woman as formerly deduced statistically (5) and it was only by considering mean values that any variation was obvious as noted above. A number of cases showed high phospholipid and free cholesterol with low neutral fat and cholesterol ester values which combination, according to Bloor, Okey, and Corner indicates active tissue. On the other hand the converse combination also occurred and furthermore such groupings of the lipids were encountered in normal non pregnant women (5). Hence it is not possible to draw any causal relationship between pregnancy and the lipid composition of the white cells from this series of analyses. This much is true, however that there is a wide variation in the lipid composition of the white blood cells in pregnancy and if the postulate of Bloor, Okey, and Corner that activity of the sow corpus luteum is associated with definite changes in lipid composition may be generalized to include all tissues then one may state there is a wide variation in the activity of the blood leucocytes in pregnancy. The relation of activity as so determined to the incidence of temperatures and puerperal infection is a problem of utmost importance to the obstetrician and is at present being further investigated.

Following parturition was noted a more definite trend in the leucocyte lipid content and distribution which exhibited in the cases studied a fair degree of uniformity. The total lipid content was increased more markedly in patients with low values before delivery. In cases examined during the first 24 hours postpartum little change in the total lipid content was found and occasionally an actual decrease was present although this period exhibits a marked leucocytosis, as noted above. Between the third to seventh day postpartum the fat of the leucocytes rose and in most cases the rise was marked so that by the first part of the second week after delivery the leucocytes contained 2 to 3 per cent total lipid. This period corresponds clinically to the establishment of an abundant flow of milk, marked involution of the uterus, a change from red to creamy yellow lochia, and a marked improvement in the general bearing of the patient. Patients examined in the second week of the puerperium were found to exhibit still a high fat content and by the end of this time the patient's general health was such as to allow her to be discharged from the hospital. One patient who consented to remain in the hospital 3 weeks was found to have a lowered fat content of her white blood cells 21 days postpartum.

Of the component lipids phospholipid followed in general the course outlined for total lipid, i. e. little or no change until the time of lactation and then a marked increase as high as 600 per cent in some cases toward the end of the first week in the puerperium. In Case 1 studied for 3 weeks the last observation indicated the phospholipid value was beginning to return to normal in 21 days postpartum. In Cases 8, 10, and 11 the phospholipid value fell in the early days of the puerperium but subsequently toward the end of the first week an increase was registered.

Free cholesterol closely paralleled phospholipid throughout the fluctuation. The increases in free cholesterol were not as extensive however and seldom exceeded 200 per cent. In Cases 3, 10, and 11 there was again a fall in value in the early days of the puerperium with a subsequent increase in the cholesterol content. By 3 weeks postpartum

(Case 1) free cholesterol had also begun to fall to within non-pregnant limits.

On the other hand cholesterol ester showed little consistency in its behavior. The amount of cholesterol ester in the white blood cells at the termination of pregnancy is low. Following parturition about one half the cases exhibited the addition or subtraction of a few milligrams per cent ester cholesterol changes which are of little significance when considered in conjunction with the possible experimental errors. In Cases 1 and 11 ester cholesterol was raised by the seventh day postpartum, while in Cases 6 and 10 it was lowered. There appears, therefore, to be no relation between the postpartum state and the cholesterol ester content of the white blood cells, the lipid having a low value in the majority of cases.

An apparent discrepancy may be noted in Table I in that the value for total cholesterol in a number of cases does not represent the sum of the free and ester cholesterol. This is due to the fact that the method for total cholesterol determines 90 to 95 per cent of the lipid present while that for free cholesterol determines 95 to 100 per cent. Thus where all the lipid present is in the form of free cholesterol the figure for total cholesterol may be less than that for free cholesterol, an apparent mathematical paradox. However since the arithmetical difference is rather insignificant it has been considered more accurate to use the actual experimental figures for total cholesterol rather than multiply these by a factor to account for the 0 to 10 per cent loss of the lipid not accounted for by the experimental procedure. While these limitations of the method are admitted it should be emphasized that of the various procedures available for the estimation of total cholesterol the digitonin oxidation micro-method as herein used is probably the most accurate.

Following parturition there occurred a consistent rise in neutral fat except in Case 11 in which neutral fat fell in value. At the termination of pregnancy neutral fat is present in relatively small amounts in the white cells. The day after delivery neutral fat began to rise in many cases markedly so and the raised values persisted for 2 weeks. This increase in neutral fat may be interpreted as

representing the function of the white blood cells in transferring fat from the involuting uterus to the fat depots

INTERPRETATION

The interpretation of the changes in fat metabolism of the blood leucocytes before and after parturition in women offers many difficulties. There are a variety of factors concerned and as these have not been fully investigated to date it is not possible to state at the present time to what alteration in body physiology and pathology the changes noted are due. During normal uncomplicated pregnancy no extraneous factor need be considered in interpreting the lipid analysis of the white cells but as has been shown there is no significant variation in the lipid composition of the blood leucocytes during pregnancy from those of the non pregnant woman. Following parturition however, a number of factors may affect the lipid composition of the blood leucocytes. In the early days of the puerperium there may be a residual effect from the strenuous exercise excitement pain, and anaesthetic of labor. This is later followed by possible effects from the involuting uterus injuries acquired during parturition lactation, and the altered general metabolism ensuing after delivery of the fetus. These factors in turn open up new fields in the functions of the white blood cells and will be considered in future publications.

Whereas the significance of the white cell reaction following parturition remains at present obscure the experimental analyses of their lipid content may be interpreted in the light of our present conception of the relation of lipid composition to functional activity. Briefly in most cases there occurs following parturition an increase in phospholipid free cholesterol and neutral fat in the blood leucocytes. Cholesterol ester exhibits no consistent trend some cases showing increased values and others lower values, little cholesterol ester was found present in the leucocytes at any time. Age parity loss of blood during parturition, length of labor and extent of perineal lacerations were apparently not factors.

Apart from the increase in neutral fat which as stated above may be due to transport of

fat by the leucocytes from the involuting uterus the findings of increased phospholipid and free cholesterol with low values for cholesterol ester correspond to those noted by Bloor Okey, and Corner (2) as indicative of activity on the part of a tissue.

The earlier suggestive and circumstantial evidence in this connection has been aptly reviewed by these authors who then proceeded in a series of excellent studies to demonstrate directly the relation of lipid composition to functional activity. Selecting a tissue the corpus luteum of the sow which passes through a well recognized cycle of activity and quiescence, they simultaneously made estimations of the lipid content and histological examination of sections removed from the same material (the results of which were separately published) studying the gland throughout its cycle in estrus and pregnancy. At the same time they made a similar study of the uterine endometrium (27) but as this tissue in the sow undergoes much less change during estrus and pregnancy than in other animals and in women (menstruation and pregnancy) the results obtained, although of the same nature were not of the same extent nor as striking as those with the corpus luteum. Seven to eight days following rupture of the graafian follicle the corpus luteum of the sow has reached a high plateau of functional activity as indicated by a solid consistency and the appearance of fully differentiated cells. At or about this time lipid analysis reveals (a) a great increase in phospholipid (300 per cent) (b) an increase less marked (66 per cent) in free cholesterol, (c) no change in cholesterol ester and (d) variable but low values for neutral fat. From the seventh to the fourteenth day the corpus luteum is at the peak of its activity and lipid analysis exhibits no change from that at the seventh to the eighth day. Following the fourteenth day, however if pregnancy does not occur retrogression sets in. This period is characterized by (a) a fall in phospholipid (b) no change in free cholesterol, (c) a great increase in cholesterol ester and (d) a marked increase in neutral fat.

Comparing the lipid changes of active tissue, as noted above with the lipid changes in the white blood cells during the middle and latter

part of the first week postpartum reveals that the essential features are similar in each case. Bloor, Okey, and Corner stress that the significant lipid variation that sets in when a tissue becomes active is an increase in phospholipid and low values for cholesterol ester. As already described, from the third to the seventh day postpartum, the phospholipid content of the blood leucocytes is increased in most cases while cholesterol esters are present in small amounts. Free cholesterol is also slightly increased as in active corpus luteum tissue but in addition neutral fat is increased while in active tissue Bloor, Okey, and Corner found this lipid low in value. It may be as noted above that this increase in neutral fat is due to a scavenger action of the white blood cells following delivery. The relation of neutral fat to activity has not been stressed by Bloor, Okey, and Corner and on the basis of their hypothesis it is justifiable to conclude that beginning about the onset of lactation there occurs an increased activity on the part of the white blood cells in women. To what this activity is due has not been established but several possibilities at present under consideration have been discussed herein.

The activity of leucocytes has been investigated in a different manner by Soffer and Wintrobe. By determining the oxygen consumption and glucosylolytic function of the cells *in vitro* they were able to show that mature and immature cells had identical activity but that granulocytes were more active than lymphocytes. While there are relatively more granulocytes in the blood of women following parturition the percentage increase is much less than the percentage increase in phospholipid. Hence it does not appear that the altered lipid composition of the white blood cells may be ascribed simply to a relative increase in polymorphonuclear leucocytes. Rather there seems to be an altered fat metabolism of the leucocytes in general at this time.

Toward the end of pregnancy there exists a compensated acidosis and some degree of simple anemia in most subjects. Both of these conditions have been stated to have a depressing effect on the activity of white cells (18, 22). In the present series of cases of pregnancy near term those whose white blood cells

contained over 1 per cent phospholipid had a higher blood hemoglobin value than those containing less than 1 per cent phospholipid substantiating to a certain degree the relation between white cell activity and anemia. On the other hand there appeared to be no relation between acidosis, as estimated by blood carbon dioxide determinations, and the phospholipid content of the white blood cells.

SUMMARY

The lipid content and distribution in the white blood cells of 11 women at or near the termination of pregnancy during lactation and the puerperium has been studied under controlled conditions of diet and exercise. It was found that age and parity did not affect the level of lipids in the leucocytes.

Before parturition the white blood cells have a wide range of lipid values though, on the average, cholesterol ester and neutral fat are low in amount and the total lipid content is reduced by about one-quarter from the mean levels in non-pregnant women.

Following parturition there is no change in the lipid composition of the blood leucocytes until the third to the seventh day. Then there occurs a rise in total lipid due to increases in phospholipid, free cholesterol, and neutral fat. These high values appear to return to normal beginning about 3 weeks postpartum. Cholesterol ester is present in small amounts throughout.

On the basis of current theory these results have been interpreted as indicating an increased activity on the part of the white blood cells during the first 2 to 3 weeks of the puerperium. The causes of this phenomenon have been discussed and a short review of the physiological chemistry of the blood leucocytes included.

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BACTERIOLOGY OF CHOLECYSTITIS

THE VIRULENCE AND SPORE FORMATION OF *CLOSTRIDIUM WELCHII*¹

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PREVIOUS to the work of Rosenow cultures from diseased gall bladders were made from the bile. Rosenow demonstrated that streptococci were found with greater frequency in the wall of the gall bladder than in the bile. In experimentation on animals, he reproduced cholecystitis in rabbits and in dogs by intravenous injection of freshly isolated strains of streptococci derived from patients with cholecystitis but he was not successful in reproducing cholecystitis in animals by injecting these strains directly into the lumen of the gall bladder. On the basis of these experiments he concluded that infecting organisms reached the gall bladder by way of the arterial blood. Rosenow also produced cholelithiasis experimentally by the same method. Nickel and Judd repeated this work. The work of Wilkie and his associates confirmed that of Rosenow regarding the etiological importance of hematogenous infection and elective localization of streptococci in cholecystitis and cholelithiasis. Wilkie and associates also found that the cystic lymph node harbored the streptococci in a high percentage of cases.

In recent years much attention has been given to infection of the biliary tract by *Clostridium welchii*. Ellis and Dragstedt have shown that apparently normal, healthy livers of adult dogs frequently harbor *Clostridium welchii*. Andrews, Rawbridge and Hrdina demonstrated that if the contents of the gall bladder of a dog were drained into its pelvis or thoracic cavity severe gas gangrene developed. Andrews and Hrdina have pointed out that frequently in cases of acute fulminating cholecystitis, the portion of gall bladder adjacent to the liver is more thickened and edematous. From this they concluded that there was primary hepatitis, with direct extension to the gall bladder.

The presence of *Clostridium welchii* in infection of the gall bladder has been noted

occasionally by many observers. Rosenow isolated this organism six times in a series of 48 cases and in a photomicrograph illustrated the presence of one organism in the wall. Gordon-Taylor and Whitby reported that *Clostridium welchii* was present in the gall bladder in 9 per cent of 50 cases in which cholecystectomy was performed and that it was recovered in 13 per cent of a series of cases in which necropsy was performed.

The purpose of this study aside from investigating the frequency with which the various infecting organisms are found in excised material and from confirming the etiological importance of streptococci was to determine the relationship between the cultural characteristics and virulence of *Clostridium welchii* isolated from gall bladders in cases in which cholecystectomy had been performed and from various postmortem materials.

The method of taking cultures from surgically excised gall bladders was essentially the method described by Rosenow. The gall bladders were immediately taken to the laboratory in a sterile covered container. The bile was first aspirated for culture then the gall bladder was opened and strips of mucosa with submucosa were excised; these were washed three times in sterile saline solution and finally ground in a mortar together with a small amount of sand and saline solution. This material was plated on blood agar and also was put in glucose brain broth, the latter medium being especially favorable for the growth of streptococci and *Clostridium welchii*.

When a suitable growth of streptococci was obtained in the primary cultures from human gall bladders, reproduction of cholecystitis was attempted in rabbits. The rabbits were given an intravenous injection, 0.5 cubic centimeter for each 100 grams of body weight of a fresh culture of streptococci in glucose brain broth on two successive days. They

Work done under the direction of Drs. H. Ross Judd and E. C. Rosner.
Now practicing in Casper, Wyoming.

were killed on the fourth day after the first injection.

For identification of *Clostridium welchii*, materials were put in Blair Wilson medium to elicit the black iron sulphide reaction also on anaerobic blood agar plates, to determine the type of colony, and in tall tubes of sterile milk to elicit coagulation with its stormy fermentation and the characteristic odor of butyric acid. Following this, smears of the cultures were stained by Gram's stain counter stained with safranin and studied microscopically for evidence of spore formation in cultures containing *Clostridium welchii*. The heat test for spore formation was used with cultures in plain broth in plain broth with coagulated egg white and in plain broth with 1 per cent plain starch.

In instances in which *Clostridium welchii* had been identified by the foregoing methods, the 24 hour cultures of the same material in glucose brain broth in which they were grown were injected intramuscularly in doses of 3 cubic centimeters, into rabbits guinea pigs and pigeons to determine their virulence the breast muscles of the pigeons being most highly sensitive and the thigh muscles of the rabbits being the least sensitive to pathogenic strains. As a final test of pathogenicity rabbits were given 10 cubic centimeters of the same cultures intravenously.

Since the results of the preliminary experiments suggested association of low virulence with loss of spore forming ability further studies were carried out. Virulent cultures of *Clostridium welchii* were obtained from material at necropsies on human subjects and pure strains were selected from colonies grown under anaerobic conditions on blood agar plates. First an attempt was made to produce *in vitro* a decrease of virulence and loss of ability to form spores, by subjecting the organisms to the action of fresh and auto-claved bile in various concentrations and then testing their virulence in animals and spore forming ability on special media. These results being negative experiments were performed on animals. Rabbits were given injections of six virulent strains, which were kept in plain broth with bile as controls in sublethal doses into the muscles of the right

hind leg, and guinea pigs were given 3 cubic centimeters in like manner. The resulting death of the guinea pigs and of about half of the rabbits, proved the virulence of the strains in question. On successive days following the injections into the rabbits a sterile needle attached to a syringe was inserted aseptically into the regions where *Clostridium welchii* had been injected 0.5 cubic centimeter of sterile physiological saline solution was injected and a small amount was aspirated and cultured. As a routine on the tenth day the rabbits immediately after being quickly killed with chloroform were subjected to necropsy, and cultures were made again from the muscles of the leg at the site of former injections the regional lymph nodes and the heart's blood. The cultures of *Clostridium welchii* thus obtained from the rabbits were again tested for spore formation and pathogenicity in guinea pigs.

The determinative bacteriological investigations of sections excised surgically from the walls of human gall bladders in 75 cases yielded the following results. In 30 cases the sections were sterile streptococci were found in 13 cases staphylococci in 26 bacillus coli in 6 diptheroids in 5, and *Clostridium welchii* in 5. Human bile from 59 cases was investigated it was sterile in 50 cases contained streptococci in 7, staphylococci in 1, *Bacillus coli* in 1, *Bacillus subtilis* in 1 and *Clostridium welchii* in 1. In 25 cases of gall stones in man the concretions were sterile in 15 cases, contained streptococci in 5 staphylococci in 3, *Bacillus coli* in 4, *Bacillus subtilis* in 1 and *Bacillus pyocyaneus* in 1. Specimens of surgically excised liver were investigated in only 2 cases and staphylococci found in 1. The gall bladders of 9 dogs were examined in 4, the wall contained *Clostridium welchii* and in 3, the bile was likewise infected.

These results from the primary cultures indicate a lower incidence of infection than has been reported by Rosenow and others. This is probably due to the fact that in this series there were few acute cases. The incidence of infection in the wall of the gall bladder from human subjects was found to be four times greater than in the bile and two

and four tenths times greater than in the gall stones. It was found also that the wall was relatively more often infected with virulent streptococci. The wall always contained streptococci when the bile did. Microscopic sections of the fundus of the gall bladders revealed a higher incidence of cholecystitis in gall bladders which were infected with streptococci.

Seven strains of streptococci isolated chiefly from walls of gall bladders, were used for experiments in elective localization. In these experiments the organism was a rather plump diplococcus that grew in glucose brain broth within 24 hours. This growth was in sharp contrast to that of some of the less virulent strains of streptococci which required from 5 days to a week to grow. With one strain of plump diplococcus cholecystitis was produced electively in each instance and the organism was recovered from the bile or wall of the gall bladder of rabbits through four successive animal passages. The organisms isolated in each instance were from the content or exudate within the gall bladder. Although this strain of streptococcus was occasionally recovered from the kidney or spleen it did not produce cholecystitis when the organism was isolated from these sources. In the 6 other cases, gross cholecystitis, with recovery of streptococci from the bile or wall of the gall bladder was produced in 4.

Clostridium welchii was isolated from the wall of the gall bladder in man in 5 instances, or 7 per cent of cases and from the bile in 1 instance or 1.6 per cent of cases. In only one acute fulminating case in man and one case in the dog was *Clostridium welchii* isolated from the gall bladder which on injection into rabbits, guinea pigs and pigeons proved to be virulent and formed spores on suitable media. In all other instances non-virulent and non-sporing large gram positive bacilli resembling *Clostridium welchii* which gave the typical reaction on Blair Wilson media, the fermentation and coagulation of milk with the odor of butyric acid, and the type of colony on anaerobic blood agar plates characteristic of *Clostridium welchii* were found in the walls and bile of gall bladders which appeared, grossly as normal. There was,

however histological evidence of low grade inflammatory change in the walls of the gall bladders in 2 cases in which *Clostridium welchii* was associated with streptococcal infection and in 1 case associated with *Bacillus coli*. In the other cases *Clostridium welchii* was the only organism isolated and there was no histological evidence of infection. In dogs infected with *Clostridium welchii* tetrad organisms were associated.

Eight rabbits survived injection into the right hind leg of 3 cubic centimeters of a virulent 24 hour culture of *Clostridium welchii* in glucose brain broth representing six virulent strains obtained from material at necropsy. Cultures from the lesions were made on successive days. The isolated organisms were invariably pathogenic for guinea pigs and were able to form spores that were heat resistant to 80 degrees C for 15 minutes, until the fifth or sixth day. Following this although the cultures were still positive for *Clostridium welchii* microscopically were characteristic in Blair Wilson media also as to type of colony on anaerobic blood agar plates and on milk media produced fermentation and coagulation with the odor of butyric acid they simultaneously had lost their ability to form spores and their high virulence. The control cultures kept in plain broth plus bile retained their high virulence as well as their spore-forming ability throughout the duration of the experiments.

Aspirated material from these rabbits became sterile on the eighth day in 2 cases and on the ninth day in 1 case and then at necropsy on the tenth day cultures from the excised muscle, regional lymph nodes, and heart's blood were likewise negative. In the other 5 rabbits local abscesses developed. These contained cheesy material from which large gram positive bacilli were isolated every day and at necropsy on the tenth day but cultures from the heart's blood and regional lymph nodes proved sterile. These large gram positive bacilli isolated from this cheesy material and from local lesions in other rabbits in which abscesses did not develop after the fifth and sixth days, gave the typical reactions for *Clostridium welchii* in the Blair Wilson and milk media, and typical colony on

anaerobic blood agar plates. These organisms, however, failed to form spores on suitable media, and proved to be of low virulence when 5 cubic centimeters of 24 hour glucose brain broth cultures were injected into the muscles of the hind legs of guinea pigs

EVALUATION

The source of *Clostridium welchii* found in gall bladders is generally conceded to be the intestinal tract and it is believed that the organisms reach the gall bladder either from the portal system or by ascending through the ducts. Judging from the results of studies of the pathogenicity and spore formation of organisms obtained from man as well as from animals it is believed that this organism is of the nature of a secondary invader and seldom is primarily the cause of cholecystitis. Further, it appears from the results obtained that a healthy person is able to reduce *Clostridium welchii* to a state of low virulence as well as inability to form spores.

Attention may be called to the fact that these rabbits were apparently well were subjected to necropsy after being quickly chloroformed and the examination was made immediately, thus eliminating the possibility of agonal or postmortem invasion and this possibly accounts for the frequent negative cultures as contrasted with the results of Cornell in whose work the rabbits became very ill had convulsions, and died spontaneously. It is also important to note that Cornell worked with entirely different strains of *Clostridium welchii* which he isolated from fecal material.

The question may be raised as to how these organisms could be *Clostridium welchii* when they did not form spores. In answer to this attention may be directed to the fact that seldom does a high percentage of organisms in any culture of *Clostridium welchii* form spores, and that total loss of spore formation is not a new phenomenon in bacteriology since Pasteur, Rous, Lubarsch and others, as described by Sternberg, have reported similar changes for *Bacillus anthracis*. The work of Weinberg and Séguin during the World War, established the fact that the virulence of

Clostridium welchii varied considerably in different cultures.

CONCLUSIONS

1 This work in the main supports the fundamental work of Rosenow regarding focal infection and elective localization.

2 It demonstrates that *Clostridium welchii*, as commonly isolated from the gall bladder of man at operation for cholecystitis and from gall bladders of healthy dogs, is of low virulence as well as being non-spore-forming. Markedly lowered resistance of tissues appears to be a prerequisite for maintenance of virulence and spore-forming ability of this organism in vivo.

3 Virulent and spore-forming *Clostridium welchii* may be injected into the leg muscles of the rabbit and, although healing occurs may be recovered after about the sixth day, in a state of low virulence and without ability to form spores, while control cultures *in vitro* retain their high virulence as well as their ability to form spores.

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BLOOD AMYLASE IN EXPERIMENTAL PANCREATITIS

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QUANTITATIVE determinations of diastatic ferments in the blood were first made by Wohlgemuth in 1908. His method depends for its endpoint on the complete hydrolysis of soluble starch as revealed by the disappearance of the blue color which it produces with iodine. The newer method of estimating blood amylase content depends upon the determination of viscosity of starch solution which changes with molecular cleavage. This method has been brought to a high state of perfection through the modification of the Davison technique by Elman and McCaughan.⁸¹ With the present technique a definite quantity of clear blood plasma and a standard starch solution are mixed in an Ostwald viscosimeter which is submerged in a water bath at constant temperature. Viscosity is determined by the time required for a definite amount of this mixed fluid to pass through the capillary portion of the viscosimeter tube which occurs with a speed proportional to the amount of amylase present. This change in viscosity is an index of the amount of amylase present in the blood plasma.

For nearly 10 years quantitative determinations of blood amylase have been made and during this time an extensive literature has accumulated yet the source distribution and function of blood amylase remain largely obscure.

The function of circulating blood diastases which are formed by organs producing glycogen according to Cohen, is intimately associated with the splitting in the liver of glycogen to sugar. Cohen further states that diastases become active only when in the tissues. According to Reid and Naravana, increased blood amylase means a decreased activity in the liver of that animal. Also a decreased blood amylase (or increased tissue amylase) signifies increased activity in the liver. Carlson and Luckhardt and Markowitz and Hough believe that blood and lymph amylase

are functionless, being by products of organ metabolism which appear in the blood for destruction or elimination. On the other hand Huber and Macleod found that a glycogen-like polysaccharide exists in the liver sinusoids and sublobular veins of the diabetic rabbit and believe that the function of blood amylase is to assist in the hydrolysis of this glycogen. Myers and Reid conclude that amylase while in the blood plays no rôle in carbohydrate metabolism and that only when in the presence of insulin is it recalled or reabsorbed into the liver cells where it exerts its enzymatic function with regard to the glucose glycogen reaction.

Elman, Arneson and Graham in studies on human blood say that low blood amylase means destruction of acini in the pancreas whereas increased blood amylase means duct obstruction. With duct obstruction there is increased absorption of pent-up ferments into the blood without atrophy of the acini. According to these authors, inflammatory processes in chronic pancreatitis probably lead to obstruction of smaller ducts by scar tissue. In acute pancreatitis, there is an abnormal absorption of ferments into the blood because of changes and destruction of the walls of the ducts so that the secretion instead of flowing on into the duodenum makes its way into surrounding tissues and thence into the blood and lymphatics. Jorns obtained high amylase values in the pancreatic tissue early in experimental mild acute pancreatic necrosis which values soon dropped below normal, and in severe necrosis there was immediate diminution of tissue amylase. Also following ligation of the pancreatic ducts, there was an immediate postoperative rise in the pancreatic tissue amylase with a rapid fall to normal. He concluded that in duct ligation there was an early rise of diastase in the pancreatic tissue the direct result of atolia. In severe pancreatic necrosis, there was a diminution of amylase in the pancreatic tissue which he says means

TABLE L—BLOOD AMYLASE VALUES IN PANCREATITIS PRODUCED BY THE INJECTION OF STERILE GALL-BLADDER BILE INTO THE DUCTUS SANTORINI

Dog		Dog 2		Dog 3		Dog 4	
Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units
0	15	0	25	0	15	0	25
1	100	1	85	1	150	1	200
2	200	2	65		150	2	200
3	150	3		3	150	3	200
4	75	4	65	4	100	4	
5	5	5	50	5	40	5	150
6	5	6				6	150
7	14	7				7	80
8	15	8	7				
9	15	9	10				
10	25						
11			10				
12	7						
13							
14							
15							

destruction of the quantity of ferment with failure of new ferment formation Crandall and Cherry found in dogs an immediate increase in blood amylase after ligation of the common bile duct with double the normal value on the second to the fourth day They also found in dogs that when pancreatic juice was injected intravenously amylase was increased in quantity in the portal and saphenous veins. It was their interpretation that blood amylase was only partially removed by the liver

The various investigators using the viscosity method have not established any definite level in absolute units for the starch splitting enzyme content in the plasma of normal dogs Each found that a normal range can be established with his own particular method According to Chesley, this probably is caused by the variable composition of the different starches used He observed that starch used as a substrate does not have a uniform composition as it is made up of several substances namely, alpha amylose (amylocellulose amylopectin) beta amylose (amylose amylopectin) and dextrins. Different batches of starch have variable amounts of α and β amylose hence different results are obtained with different batches. Elman and Mc

Caughan, using 7 per cent starch found values for normal dogs to be between 15 and 25 units whereas Johnson and Wies found normal values to be 6 to 13 units Myers and Reid obtained values of 14.6 and 19.4 or an average of 17 units Cohen, using 7 per cent starch found normal values to be between 12 and 67 units, with an average of 37 We found values (viscometric method) for 69 normal dogs, using 0.1 cubic centimeter clear blood plasma and 3 per cent Lintner's starch solution to be 20 to 56 units with an average of 36 The unit determination varied slightly with different batches of Lintner's starch Johnson and Wies found in 4 animals that when the pancreatic ducts were ligated the amylase concentration of the serum increased from 9 to 20 times normal to reach a maximum on the third day after operation Following this there was a gradual decline to approximately normal on the twelfth day after operation Reid *et al* (16, 17) found in dogs after pancreatectomy, if kept alive with insulin that there is a decrease in blood amylase for a few days then a rise to normal or to a point higher than pre-operative level When insulin was stopped the amylase again dropped Reid and Narayana noted that insulin lowers blood amylase but increases liver amylase.

TABLE II.—BLOOD AMYLASE VALUES IN PANCREATITIS PRODUCED BY THE INJECTION OF ETHER INTO THE DUCTUS SANTORINI

Dog 1		Dog		Dog 2	
Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units
	56		75		56
	300		90		300
1	300		85		300
4	70	3	60	4	300
6	100	4	60	5	180
7	60	5	30	6	50
8	60			7	50
9	45	8	6	8	75
10	15	17	10	9	65
	20	20	10		65
			3		50
			14		100
			7		10
			10		50
			4		50
			5		50

From these citations, it is apparent that there is a wide divergence of opinion as to the source, distribution and function of blood amylase. In addition there is not even a close parallel in results as to the amount of amylase present in the circulating blood of normal dogs. While the methods of determination have been brought to a high state of perfection, standardization apparently is lacking.

METHODS

Since temperature reaction and salt concentration affect the viscosity they must be controlled and kept uniform. A temperature of 37.5 degrees centigrade does not affect stability of amylase; hence this temperature is used throughout the experiments. Three per cent sterile buffered starch solution (Lüntner's) was used as a substrate (6). It will keep indefinitely if kept sterile, thus obviating the necessity of preparing fresh material each time. Values for amylase are expressed in units that indicate a quantity of amylase that will effect in 1 hour a change of 20 per cent in the viscosity of 5 cubic centimeters of a 3 per

cent buffered starch solution. Venous blood (fasting) was collected in oxalate solution and examined within 2 hours. To 3 grams of Lüntner's starch, sufficient buffer solution (Ph 7) is added to make 100 cubic centimeters. This is boiled for 1 minute over a free flame and autoclaved at 18 pounds pressure for 15 minutes. It is then filtered through paper or cotton and kept sterile. All pipettes and viscosimeters are plugged with cotton to prevent contamination with saliva. Five cubic centimeters of the starch solution is added to an Ostwald viscosimeter and placed in a glass water bath at 37.5 degrees centigrade. The temperature is kept constant with an electrical control. Several determinations of the viscosity of the starch solution are made with a stop watch. The time required for 5 cubic centimeters to flow through the capillary tube is noted, which is the viscosity time of the solution. Clear blood plasma (0.1 cubic centimeter) is added and the time is noted. Readings are made every 3 minutes until the viscosity shows a reduction of 20 per cent as previously calculated. One amylase unit is defined by Davison as the amount of enzyme which will accomplish this change of viscosity in 1 hour. In other words one unit of amylase is that amount of enzyme which requires 60 minutes to reduce the initial viscosity 20 per cent.

Example: If 0.1 cubic centimeter of clear blood plasma or enzyme solution should cause a reduction to 80 per cent of the original viscosity in 15 minutes, the 1 cubic centimeter of the solution would contain $\frac{(60 \text{ min} \times \text{vol.})}{\text{Time in min.}}$

or $\frac{60 \times 10}{15}$ equals 40 units of amylase per cubic

centimeter

In a previous paper (3) we noted the blood chemical changes in experimental acute pancreatitis. Five different solutions were utilized in these experiments. Infectious solutions, sodium taurocholate, sodium salicylate, ether and gall bladder bile were injected into the ductus Santorini. The degree and extent of the inflammatory reaction which they produced was determined by complete pathological studies. It was found that the inflamma-

tory reaction was greater with solutions of *Bacillus coli* and least with sterile gall bladder bile. The same solutions were used in the following experiments.

OBSERVATIONS

The most violent inflammatory reaction was found to be produced by the injection of infectious material. Following the injection of a saline suspension of *Bacillus coli* or a suspension of *Bacillus coli* in bile, an astounding rise in blood amylase was observed. In one instance it reached as high as 1200 units. This amounts to 30 times normal. Sodium taurocholate produced a pathological lesion next in severity to infectious material. Following its injection into the pancreas the blood amylase value rose to 800 units which did not return to normal in 13 days. Diethyl ether produced acute pancreatitis which pathologically was not as severe as that produced by sodium taurocholate. Here the pancreatitis was accompanied by a rise in blood amylase to 350 units which remained high for several days. The injection of sterile gall bladder bile was not as reactive as any of the above but was accompanied by a rise in blood amylase which reached a maximum figure of 200 units and persisted from 2 to 6 days before returning to normal.

We have compiled our data in tabulated form, which is self explanatory.

EVALUATION

Our studies have been made on dogs thus permitting controlled experimental procedures and observations. In every instance the pancreatic ductus Santorini was injected and ligated with silk. In addition, many acini of the pancreas were damaged so that from the beginning the combination of duct obstruction and acinar destruction was present. This condition persisted until autopsy.

From these observations, it is apparent that experimental acute pancreatitis in dogs is immediately accompanied by a sharp rise in blood amylase. Also this rise in amylase is proportional to the severity of the lesion. It is further apparent that this rise is only temporary, as in every instance except when infectious material was injected, the blood

TABLE III.—BLOOD AMYLASE VALUES IN PANCREATITIS PRODUCED BY THE INJECTION OF SODIUM TAUROCHOLATE INTO THE DUCTUS SANTORINI

Dog		Dog #	
Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units
0	40	0	40
	660	1	450
2	600		600
4	800	3	600
5	450	4	800
6	800	5	500
7	300	6	450
8	600	7	300
1	800	8	215
1	170		5
14	11	13	70
15	17	16	40
11	60		
21	66		

amylase approached a normal figure before the animal was sacrificed, and yet in each instance a severe pancreatic inflammatory reaction persisted after the amylase returned to normal value.

In the light of the present available facts several different explanations of the phenomenon are possible. We possess insufficient information to separate these possibilities. Temporary increase of blood amylase immediately accompanying acute inflammatory lesions of the pancreas may be due to the manufacture by the pancreas of excessive amounts of amylase which overflow into the blood. This would seem plausible but just why this excessive amylase concentration of the blood should return to essentially a normal figure while active acute inflammatory reaction remains in the pancreas is more difficult of comprehension. It might be explained by either a failure of the pancreas to continue the manufacture of excessive quantities of amylase, or it might be that mechanisms are set in motion which filter out these excessive amounts of amylase practically as fast as they are formed so that after they have adapted them

TABLE IV—BLOOD AMYLASE VALUES IN PANCREATITIS PRODUCED BY THE INJECTION OF BACILLUS COLI INTO DUCTUS SANTORINI

Dog		Dog		Dog 3		Dog 4		Dog 5	
Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units	Days before and after operation	Blood amylase units
	14		8		78		40		45
	400		100		800		1,400		800
	600		20		450		500		800
3	600	3	100	3	120	3	600	3	600
	600		20	4	200	4	250	3	200
4	600	4	7	4	450	4	25	7	100
7	200	9	20	7	420	8	20	9	100
8	200			8	600	9	65		
9	200				85	10	57		
	100				25		40		
	100			7	45	5	44		
5	600					16	45		
16	600					13	40		
18	600						30		
	70					35	35		
	90					36	34		
20	9								
21	90								
24	30								
4	200								
11	70								

elves to the new circumstance of the acute inflammatory reaction in the pancreas the blood amylase is held at an essentially normal figure. The interrelationship between insulin and amylase in carbohydrate metabolism has been stressed by Myers and Reid and others. Acute diffuse pancreatitis, such as we have produced undoubtedly has involved the islands of Langerhans. With the insulin-forming tissue thus involved, we have an additional factor for consideration.

Our evidence would lend support to the views of Elman. It may very well be that the explanation for the return to normal of the blood amylase is the deposition of fibrous tissue along with other factors which tend to wall off the inflamed areas and which occur after the lesion has existed for a time. Although Jorns is of the opinion that in high grade tissue destruction or increased stasis of long duration the ferment is either destroyed

or there is cell failure in its formation. We are not prepared at this time to interpret the observed facts definitely.

CONCLUSIONS

1. We have studied the blood of normal dogs, on which viscometric amylase determinations were made. With 3 per cent Litner's starch solution as the substrate and using 0.1 cubic centimeter clear blood plasma, we find the normal amylase content to be 20 to 56 Davison units.

2. Injury of the pancreas is accompanied by a marked temporary rise in amylase. The more severe the injury the greater the rise in amylase.

3. Elevation of blood amylase is only transient and severe injury of the pancreas after the first week is accompanied by normal blood amylase even though pathology of the pancreas persists.

4 Chronic injury of the pancreas is accompanied by normal or slightly increased blood amylase

5 Degenerative changes such as cloudy swelling and necrosis about the central vein in the lobules of the liver were a constant observation. Pathological studies checking the degree of pancreatitis were made in all cases.

6 Blood amylase determinations are indicated clinically in determining early acute pancreatic pathology

We desire to express our appreciation to Dr C. J. Weber, director of the Research Laboratory at the University of Kansas, for his technical assistance in this work

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CLINICAL SURGERY

FROM THE SURGICAL CLINIC NEW YORK POST-GRADUATE HOSPITAL

CARCINOMA OF THE COLON

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IN any operative procedure for cancer of the colon peritonitis stands out as the greatest danger and the most serious complication. In our operative procedure the dangers of this obstacle have been greatly lessened as we do not clamp the bowel intraperitoneally nor do we cut the bowel with a knife or cautery thereby blocking any infection from the cut lumen into the general peritoneal cavity.

In preparing these patients for operation a second important factor must be kept in mind, that is that they are suffering from reduced general health and strength due to advanced years and that they are often afflicted with some debilitating systemic disease. Consequently the following steps must be taken: repeated blood transfusions must be given and, several days before operation, 1,545 cubic centimeters of glucose and saline solution should be administered along with a high caloric non-residue diet and any obstruction should be relieved by repeated irrigations. The blood transfusions, the introduction of fluids, the use of a high caloric diet, and the cleansing of the bowel as much as possible by irrigations, increase the safety for the following operative procedures.

In all cases of cancer of the colon I make a preliminary cecostomy through the McBurney grid-iron incision, as shown in Figures 1 to 4, the cecum being drawn up as in Figure 5. A Paul's tube is introduced into the cecum (Fig. 6) this step being delayed for 48 hours to insure proper walking-off. This tube, of course, drains away quantities of fluids which have to be replaced by intravenous injections of 5 per cent glucose normal saline solutions, and also by clyns and repeated blood transfusions. The blood chemistry is closely watched. When the condition of the patient warrants it, he is sent home for a 3 months' rest before the radical abdominoperineal excision is performed. Upon re-entering the hospital, a complete check-up is again made. The administration of transfusions—glucose—saline—and the

application of an indwelling catheter are ordered. A median or left incision is made and the mesentery of the left colon is resected from a point above the growth down through the peritoneal reflection, the gland bearing area being excised as in Figures 7 to 9. The abdomen is then temporarily closed. The patient is placed in the lithotomy position for the perineal resection. The area is painted with iodine, gauze soaked with iodine is introduced into the rectum, and the aperture is closed with a continuous suture. The perineal incision is made preferably with a cautery as in Figure 11 and continued until sufficient rectum extrudes so that a sterile rubber glove can completely cover the lower bowel, as in Figure 12. Having dissected up to the peritoneal reflection, the abdomen is re-entered, the peritoneal reflection dissected, and the entire loop is carried out side the abdomen. Before this is done a separate incision is made in the left rectus muscle and the entire vascularized bowel is carried through this aperture for the purpose of fashioning a single barrel colostomy. The peritoneal reflection is closed and the meson in the abdomen is also closed in the usual manner. The cut edges of the sigmoid mesentery are sutured to the left parietal peritoneum to prevent herniation. The extraneous gut is double clamped a few inches from the colostomy opening and severed with a cautery, completing the single barrel colostomy. With these manipulations, there is very little chance of infection and peritonitis.

In those cases of tumor of the left colon in which the growth is resectable, it has always been my contention that a modified Mikulicz and Paul operation is preferable. The old so called ecrantation operation is seldom used at the present time. All criticism seems to be directed against the old procedure however. The preliminary colostomy operation is performed and the patient is sent home to recuperate. Two months later the patient re-enters the hospital and a complete check

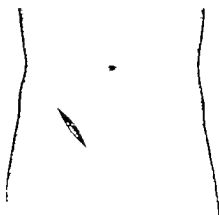


Fig. 1



Fig. 2

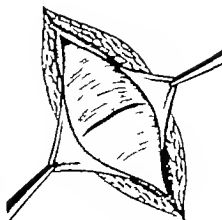


Fig. 3

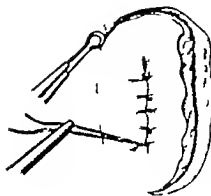


Fig. 4

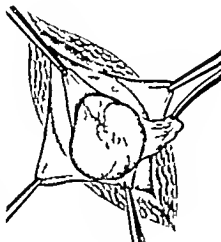


Fig. 5

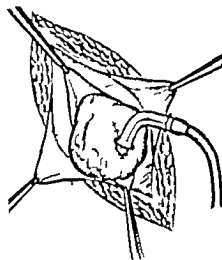


Fig. 6

up is again made. The usual incision is made on the left side of the median line and the growth surrounded with laparotomy pads. Manipulation should be as gentle as possible while the incisions are made in the mesentery. The incision should be sufficiently long that the growth can be drawn well outside the abdomen and the two barrels of the colon approximated for a distance of 2.5 to 3 inches. The approximation is made by sutures through the cut edges of the mesentery. Due care should be used to determine the viability of the approximated barrels by first determining the efficiency of the circulation. In dealing with carcinoma of the left part of the transverse colon and the left colon and sigmoid, we are able to draw more colon out of the abdomen if first, we sever the phrenicocolic ligament fairly high up. Also in sizing the peritoneal reflection on the outer or left side of the resected area we are enabled more readily to approximate the barrels of the colon.

In the newer Paul Mikulicz type of operation no sutures are used to approximate the parietal

peritoneum with the colon proper. If it be necessary, however, the parietal peritoneum can be sutured to the cut edges of the mesentery. At the end of 72 hours the tumorous mass can be resected with a cautery and the usual follow up procedures of the Paul-Mikulicz operation can be accomplished without any undue haste.

By means of a continuous suction apparatus we are better able to keep the wound clear of debris. With the preliminary caecostomy and suction faster healing is accomplished. This same operative procedure can be used for carcinoma of the transverse colon. When dealing with malignant growths in the right colon, however, I use the Paul-Mikulicz type of operation, the terminal ileum being used as one barrel and the hepatic flexure of the colon as the second barrel as has been suggested by Frank H. Lahey. In this latter procedure I use a preliminary ileostomy about 12 inches or more proximal to the caecum and introduce a pezzet catheter which has been witzelized according to the Hendon technique. Thus more

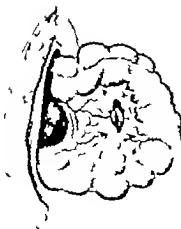


Fig. 1

or less, continuous suction is applied to the catheter for the first 2 hours to avoid infection and suppurative wound edges.

In multiple malignancy of the right, or transverse colon or the left colon the Paul-Mikulicz type of operation can be utilized with the terminal ileum as one barrel and the sigmoid as the other. If for any reason a preliminary caecostomy is inadvisable owing to tremendous dilatation of the cecum caused by the carcinomatous constricting growths where we might meet the Dehnung-Geschwüre of Kocher with ischemia or ulceration due to faulty blood supply, we then do a preliminary ileostomy using the Hendon technique.

The postoperative care of these patients is very important. While the patient is in the operating



Fig. 2

room, a continuous infusion of glucose 5 per cent and normal saline solution is given. Upon the patient's return, 4,500 cubic centimeters of the glucose and saline solution are given by hypodermoclysis or venoclysis in each 24 hours. Arrangements are made for blood transfusions to be given as required. In any case one transfusion after operation is always given. Parotitis is a complication which causes some anxiety but in recent years the early use of radium has had a most favorable influence.

In all my cases, I have used an indwelling catheter and have used irrigations of boric acid after operation for at least 1 week. The patients are made comfortable by the use of morphia and the absence of any fluids by mouth for at least 48

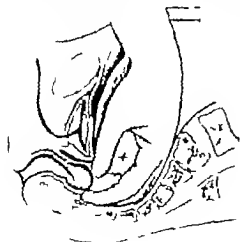


Fig. 3

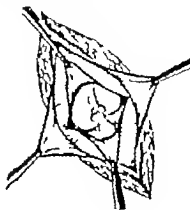


Fig. 4

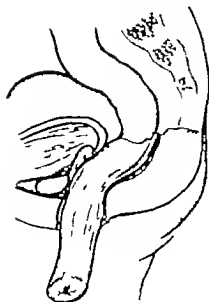


Fig 11

hours. The removal of the gauze pack from the peritoneum is facilitated by soaking the gauze pack with hydrogen peroxide and irrigations of normal salt solution. Special attention should be given by the attending surgeon to instruct the patient as to the care of the colostomy opening.

CONCLUSIONS

In the operative procedures described, not once have we used clamps or severed the colon by cautery as is done in all forms of anastomosis. Nor do we suture the colon wall to the parietal wall of the peritoneum. The mortality of colon surgery, as I have stated before, is still very high. In my opinion it will always remain so if surgeons in general adopt any of the so called aseptic technique operative procedures which have been so carefully described. I believe that the term is a misnomer as every time we apply clamps across the lumen of the colon we traumatize the wall so severely that hordes of microscopic or ultra microscopic bacteria are spilled into the peritoneal

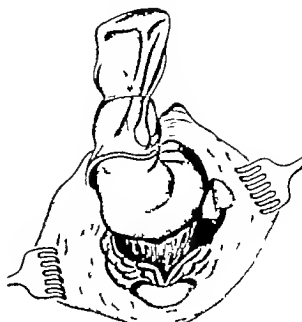


Fig 12

cavity. So infection and tension are the chief adverse factors of all colon operative procedures to date. In the operation that I have described the mortality should be so much lower that I am sure its lack of danger will appeal to the careful and conscientious surgeon.

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REPAIR OF RECURRENT AND DIFFICULT HERNIAS AND OTHER LARGE DEFECTS OF THE ABDOMINAL WALL EMPLOYING THE ILIOTIBIAL TRACT OF FASCIA LATA AS A PEDICLED FLAP¹

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FORTY years ago in one of his early contributions to the operative treatment of inguinal hernia, Halsted began his remarks with the following quotation from Schuh, a Viennese surgeon of an earlier generation "If no other field were offered to the surgeon for his activity than herniotomy it would be worth while to become a surgeon and to devote an entire life to this service." Recognizing the limitations of surgery in the pre-antiseptic era, one may fully appreciate the significance of Schuh's statement.

In the remarkable treatise of Astley Cooper on hernia which appeared in 1804 the pathogenesis and anatomy of hernia were accurately described in a manner in accord with later day conception.

Operative efforts in the treatment of hernia however remained limited to the release of strangulation. Even the advent of anesthesia and asepsis, the events of greatest consequence in the evolution of surgery awaited the perfection of an adequate technique before surgery could offer sufferers from this malady promise of prolonged relief. In 1889 Basmann came forward with the description of his operation for the repair of inguinal hernia, which procedure together with contributions from numerous sources established permanently the worth of the operative method in dealing with hernia.

The passing years have indicated nevertheless, that a number of cases remain refractory to the usual method of repair. The high incidence of recurrence of direct inguinal hernia repaired by the ordinary hernioplastic technique is indicated by every report in which the ultimate results are carefully scrutinized.

Thirty two years ago McArthur utilized living sutures of fascia cut from and left attached to the adjacent edges of the incised external oblique aponeurosis to buttress and strengthen the hernia repair. Twenty years later Gallic and LeMesurier cut similar strips of fascia lata and brought the tissues in the groin together by a latticework of these free fascial strips woven back and forth through and over the approximated structures. Already in 1909, Kirschner had demonstrated the ability of strips or sheets of fascia to survive in-

dependently when transplanted as autografts. The employment of these methods in the repair of recurrent and direct hernias has contributed materially to satisfactory and lasting results in the surgery of difficult hernias.

The operative procedure which the writer wishes to present is a new application of a well established principle in plastic surgery viz the transplantation of a musculotendinous structure with its nerve and blood supply preserved intact. The iliotibial tract may be readily swung up from the thigh into defects of the abdominal wall. This strong sheet of fascia is directly continuous with the tensor fascia lata muscle which takes origin from the crest of the ilium. The innervation and blood supply of this muscle come from the superior gluteal nerve and artery and reach the muscle from behind where they course over the fibers of the gluteus minimus muscle. The tensor fascia lata muscle may be employed as the pedicled support and base for the mobilized iliotibial tract. This circumstance together with the facility of transfer and lack of compromise of any important function performed by this tendinous structure in the thigh, eminently fits it for the repair of defects of the abdominal wall and particularly of the inguino-femoral region.

This method was first used by the writer about 5 years ago in repairing a defect in the lower left abdomen of a young woman after excision of a desmoid tumor. Removal of the neoplasm necessitated the sacrifice of the entire lower portion of the internal oblique with a portion of the transversus abdominis muscle together with the entire transversalis fascia in the groin as well as the external border of the rectus sheath. It was immediately apparent that approximation of the residual tissues to close the defect was impossible. The peritoneum bulged into the wound and the only remaining tissue which could be utilized for closure was the external oblique aponeurosis. The defect appeared too large to be securely closed by weaving over it free strips of fascia lata. It was at this juncture that the plan of employing the iliotibial tract as a pedicled graft on the tensor fascia lata muscle suggested itself as a feasible procedure.

SUMMARY OF CASES IN WHICH THE FLAP OPERATION HAS BEEN DONE

The operation has been performed fourteen times to date twice for the repair of large defects necessitated by the removal of malignant tumors of the abdominal wall four times in the mending of large vertical incisional hernias once in the repair of a prominent bulge in a McBurney incision, once in the closure of a large recurrent femoral hernia, and six times in securing an adequate support in the repair of large inguinal hernias. Of these 6 inguinal hernias all were recurrent direct hernias with one exception. This patient had a swelling in the scrotum which measured 15 by 18 centimeters. At operation great difficulty was had in returning the many coils of small intestine contained in the sac to the peritoneal cavity and all efforts proved futile until the fibers of the internal oblique were cut across. After the sac was evacuated of the herniated intestinal coils, the spermatic cord was found to be so elongated that the testis could be brought 3 inches below the patella.

The first patient with a hernia operated upon by this method had in effect both a femoral and a direct inguinal hernia, the inguinal ligament having been lost in three previous attempts by experienced surgeons at repairing the hernia. He still has a large direct hernia on the left side which also has been operated upon three times previously. Its repair by this method will be undertaken as soon as it is convenient for him to have it done.

One patient, an obese woman of 33 years, who had been completely invalidated and bedridden because of a large incisional hernia, succumbed from diffuse minute cerebral hemorrhages and fat embolism after the repair of the defect by this method. Over a period of 7 months, attempts at improving her strength by getting her up gradually resulted in her being able to stand and take a few steps with assistance. The risk of the operative procedure was well appreciated. A very satisfactory closure was obtained by the use of the iliotibial tract as a flap. About 24 hours after operation, hyperthermia developed (temperature 107 degrees F) which proved refractory to treatment and exitus occurred 48 hours after operation. Minute cerebral hemorrhages were demonstrated at postmortem examination. Death was believed to have been due to fat embolism. The employment of the fascial flap probably played no important rôle in her death.

In this group of difficult hernias there has been no recurrence save that in Case 13. In this patient who had two large incisional hernias

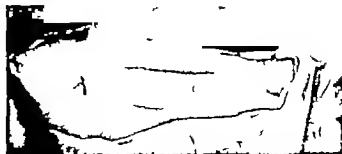


Fig 1 A photograph of position of the patient on the operating table. The tilt of the thigh permits of access to the strong iliotibial tract the borders of which are outlined. Crosses are placed over the anterior superior spine the greater trochanter and the biceps femoris tendon.

which were repaired simultaneously, there appears to be a very small defect in the lesser hernia which the fascial flap did not cover. The particulars of each case are related in the summaries of the case histories.

TECHNIQUE OF THE OPERATION

Careful pre-operative preparation of the skin is an important item of the operation. The routine method of skin preparation for all elective surgery at the University Hospital is as follows. A careful washing of the skin with tincture of green soap and water employing gauze sponges is done, after the hair is shaved off. The proposed operative fields are then sponged successively with benzine and ether. Finally a few gauze squares saturated with alcohol are fastened over the prepared areas beneath a sterile towel, which is held in place beyond the field of preparation by pieces of adhesive tape. When this dressing is later removed in the operating room, the skin is once again gone over with benzine and ether before the conventional tincture of iodine is applied in two coats. These in turn are removed when dry by the application of a saturated alcoholic solution of sodium thiosulphate (Richardson's solution) which decolorizes the iodine.

In the placing of the patient on the operating table, it is important to tilt up the pelvis and thigh of the side to be operated upon, by placing beneath them a few padded sand bags (Fig 1). This maneuver permits of better access to the posterior and stronger portion of the fascia lata, viz., the iliotibial tract, which is to be mobilized as a flap. Spinal anesthesia or ethylene and ether have been most frequently employed.

In patients with large incisional hernias, in whom the closure of the defect will necessitate considerable reduction in the size of the abdominal cavity, I have made it a practice to insert a Levine tube with multiple perforations through

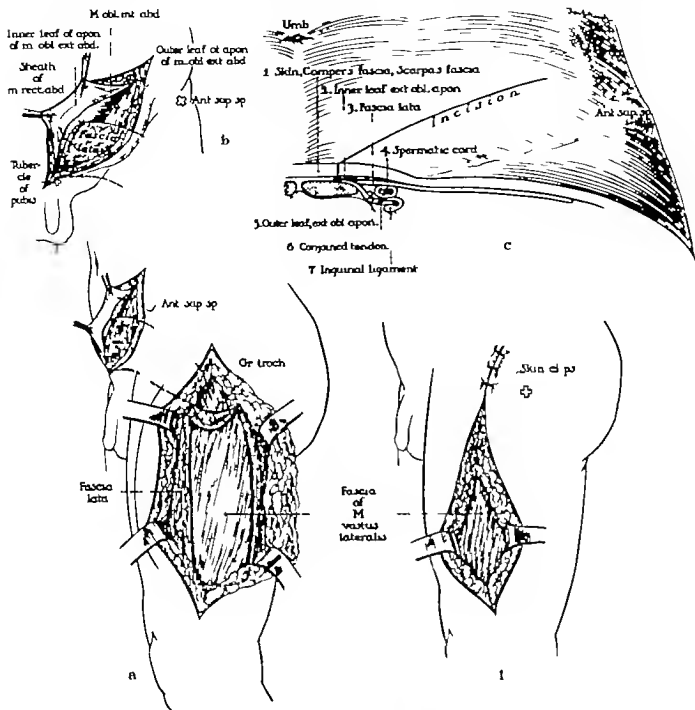


Fig. 3. a, A sketch showing the iliothoracic tract of fascia swung into the groin by tunneling over Poupart's ligament in the repair of a recurrent inguinal hernia. b, The conjoined tendon has been sutured to Poupart's ligament and the outer leaf of the aponeurosis of the external oblique has been tacked down upon the fibers of the internal oblique and the conjoined tendon. The fascial flap is sutured to the external border of the rectus sheath and overlies the

spermatic cord. The inner leaf of the external oblique aponeurosis is in turn sutured down upon the fascial flap. c, The structural relations obtained in the repair are shown in this sketch. d, The closure of the thigh wound. No attempt is made to cover the fascial defect incident to the removal of the fascial flap. Because of the covering of the vastus lateralis muscle by the fascia there is no tendency to muscle hernia.

fascia lata muscle from behind and there is practically no danger of injuring them in raising the flap (Fig. 2 c).

In the repair of defects of the abdominal wall occasioned by the excision of neoplasms it is

best to pull the flap up beneath Poupart's ligament with the fatty side down. The fascia is then sutured to the edges of the remaining tissues with interrupted sutures of chromic catgut (single No. 1). In event that fixation of this flap

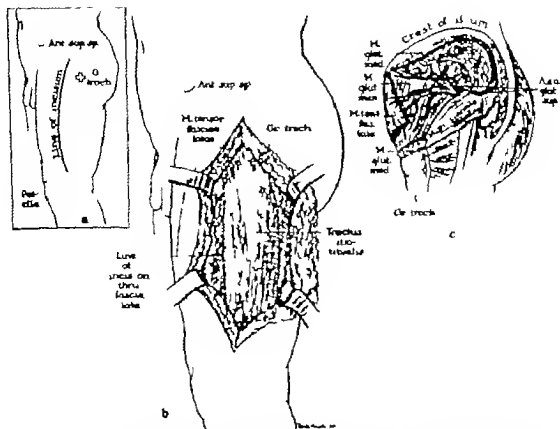


Fig. 2. The incision in the thigh. b. The incision in the fascia lata after undercutting the skin. c. A sketch illustrating the innervation and blood supply of the tensor

fascia lata muscle from the superior gluteal nerve and artery. They come from beneath and come over the gluteus maximus muscle beneath the gluteus medius.

the nose into the stomach on the evening anterior to operation. The distal end of the catheter makes its way meanwhile into the duodenum and by the exertion of continuous suction on the duodenal tube with a water siphon after operation, distention can be prophylactically avoided.

I have elsewhere previously described in brief form some of the details of the operative procedure (33). A vertical incision is made over the anterolateral aspect of the thigh of the same side as the defect. The ends of this incision are tapered laterally to permit of wider undercutting of the posterior skin margin. The incision is begun about 3 inches below the anterior superior spine and may be extended downward to the knee (Fig. 2 a). In the repair of inguino-femoral defects, the lower margin of the incision need not go past the mid portion of the thigh. When the fascial flap is to be employed as a patch over the closure of a long incisional hernia, a generous incision in the thigh is necessary. The variable

lengths of femora are also to be borne in mind. Disparities in height of people are more due to differences in lengths of the lower extremity than to dissimilarities in trunk measurements. In short individuals, therefore, a relatively longer incision in the thigh may be necessary.

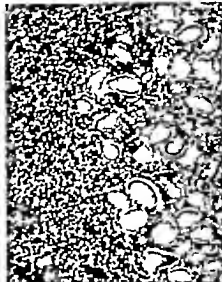
The incision in the fascia is made just lateral to the sartorius and is prolonged downward over the vastus lateralis. In the lower angle of the wound, the incision in the fascia is extended in a posterior direction for about 4 inches. A vertical extension of this incision is then made upward from its most posterior margin. In this manner the distal tract of fascia is mobilized as a flap. When it is cut loose from the intermuscular septum between the biceps femoris and the vastus lateralis muscles, it remains suspended by the tensor fascia lata muscle only. The inferior surface of this flap is smooth; the superior surface is covered by a variable amount of fat. The superior gluteal nerve and artery reach the tensor



c



d



e

Fig. 4. a, The defect created in the abdominal wall by the excision of a desmoid tumor (Case 1). The fibers of the internal oblique muscle and the transversalis fascia have been excised. A portion of the rectus sheath has also been excised, and the anterior and posterior borders have been reapproximated. b, The iliotibial tract of fascia from the thigh pedicled on the tensor fasciae latae muscle has been swung up beneath Poupart's ligament to close the defect.

c, A recent photograph made after excision of the desmoid tumor and repair of the defect. The abdominal wall is strong and there is no suggestion of hernia even when the patient strains. d, Photograph of tumor. The excised portion of the rectus sheath may be seen at the left of the picture. e, Low power photomicrograph of the tumor showing infiltration between the muscle bundles of the tumor. $\times 160$.

sutures. The fascial flap from the thigh is now swung over the spermatic cord and anchored to the external border of the rectus sheath and the inner leaf of the external oblique aponeurosis is sutured over the fascial flap. In the event that the upper surface of the fascial flap is unusually fatty a strip of fat is pushed aside where the fascial flap is to be sutured to the inner leaf of the external oblique aponeurosis.

In operations done for recurrent direct inguinal hernia under spinal anesthesia, the nature of the support lent to the weak tissues by this method of repair may be readily demonstrated by having the patient cough or strain before and after transfer of the fascial flap.

Meticulous care is observed to obtain absolute hemostasis in both wounds, and the subcutaneous tissues are approximated by several interrupted sutures of fine plain catgut which also catch the fascial flap such that dead spaces are effectually obliterated. The skin is approximated by metal clips which are left for 4 or 5 days, when alternate ones are removed, and the remainder on the day following. A small rubber tissue drain is placed subcutaneously and left for 24 or 48 hours after the repair of a large incisional hernia. Inguinofemoral hernias have not been drained. No attempt is made to close the fascial defect in the thigh resulting from excision

of the flap. It should be stated here, that, after excision of a fascial flap of about 4 inches in width, the gap is considerably widened by the retraction of the fascia. The vastus lateralis muscle remains covered by its fascia after mobilization of the iliotibial tract and muscle hernia does not occur. A small stab wound is made beneath both angles of the thigh incision to permit of the introduction of a small rubber tissue drain at the lowest point. After 48 hours these drains are removed. A fairly snug circular bandage is applied over the gauze dressing of the thigh wound. In bed one or two pillows are placed below the knee to keep the thigh flexed.

These wounds usually heal kindly. The patient is kept in bed for 14 days or more, during which time he moves freely from side to side. A slight fullness persists beneath the anterior superior spine where the flap is swung upward. No functional disability in the thigh or leg is complained of because of transfer of the iliotibial tract. The only complaint which a few patients have made is that of temporary paresthesia at the upper end of the thigh wound, probably caused by the division of the lateral femoral cutaneous nerve.

INDICATIONS FOR THE OPERATION

It is difficult to appraise accurately the indications for the performance of this operation. It is

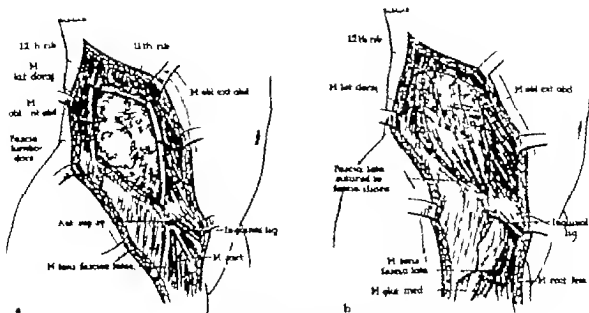


fig 5 (Legend on opposite page)

no easy matter to say exactly in which instances a sheet of fascia lata employed as a free patch after the method of Kirschner would be the method of choice, or when free strips of fascia employed as an interweaving suture as advised by Galbre and LeBlanc is to be preferred. It is to be admitted that both these methods permit of more universal application in the correction of tissue defects than does the writer's pedicled graft. In the repair of recurrent abdominal hernias and other large defects of the abdominal wall, however, there is a valuable in the use of this method an effectual means of affording adequate and lasting support. The employment of a pedicled graft with its blood and nerve supply preserved intact together with ease of transfer and absence of compromise of any function performed by the tendinous structure in the thigh has much to commend it. Even though the survival of free strips and sheets of fascia has been adequately demonstrated, certainly no one will contend that the transplantation of such potentially dead tissue is superior to the employment of a living graft. In difficult hernias, which test the worth of any method of repair, the iliofemoral tract of fascia pedicled on the tensor fascia lata muscle as its base will give a support equal in strength and probably superior in healing qualities to that afforded by any other available method.

The employment of a pedicled sheet of fascia or muscle is also a well established principle in hernia

repair. Halsted incised the anterior rectus sheath and turned it down over the conjoined tendon and approximated it to Poupart's ligament to afford a more adequate support for the weakened tissues. DeGarny in 1896 first employed the sartorius muscle in the plugging of a large femoral hernial orifice. Since the use of this muscle has been practiced for similar purposes by a number of surgeons (19, 31) Bloodgood advised its use for the reconstruction of Poupart's ligament. The adductor longus and pectineus muscles have been similarly employed to plug the femoral ring. In the preparation of this paper I have tried to ascertain whether any method similar to that here described has previously been published. In 1910, Ach related the use of a pedicled flap of fascia lata 10 to 12 centimeters in length taken from just beneath Poupart's ligament to close the femoral ring. Polya in 1913 reported the employment of a compound pedicled flap of skin, fascia, and sartorius muscle in the repair of a large inguinal hernia, cut from about the same location as Ach's fascial flap. In 1924, Mackenzie of New Zealand described under the title of "The Repair of Large Abdominal Hernia by Muscle Transplantation" the use of the tensor fascia femoris muscle itself for the repair of a large defect in the lower abdomen. These methods, and particularly the latter though similar in principle to that described here present significant differences obvious in the accompanying illustrations or on perusal of the text of this paper.



c

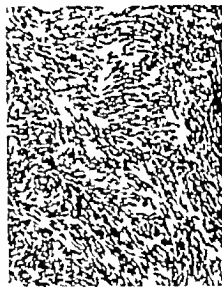
Fig. 5 a. The defect in the abdominal wall in a young girl of 15 years (Case 2) after excision of a recurrent spindle cell sarcoma. A portion of the ilium has also been chiselled away to permit removal of a portion of the fascia covering the iliacus muscle to which the tumor was attached. b. Closure of this defect by the employment of a pedicled flap of the iliotibial tract. c. Photograph of the patient before operation. d. Photograph of the patient 17 days after operation. e. Photograph of the tumor. f. Low power microphotograph of the tumor. a spindle cell sarcoma. $\times 160$.



d



e



f

I have once employed the fascia covering the gluteus medius muscle for the closure of a defect occasioned by the removal of a sarcoma of the innominate bone involving some of the abdominal muscles in a location similar to that shown in Figure 5. The gluteus medius fascia however is fairly intimately fused with the gluteus medius muscle, and its transference results in noticeable disability of the hip joint.

The only other autoplasmic substances suggested for the closure of such hernia defects which have proved of some value, but have been used less frequently since the employment of fascia came into vogue, are the use of free grafts of periosteum or bone itself.

Among heteroplastic substances, a large number of different materials may be enumerated such as filigree wire, celluloid, lead and rubber plates, none of which enjoy usage today. The use of ox fascia as suggested by Koontz (17) appears to have met with successes in the hands of several surgeons.

The earlier work of Nageotte and his colleague Sencert, as well as that of Koontz, Rosenblatt and Meyers and Wolfsohn would appear to have established the practicability of employing such heteroplastic fascial grafts. Koontz reports the use of this material in 85 hernias with only three recurrences. G. W. Horsley reports, however, that whereas he found that alcohol preserved ox



Fig. 6. a. Left. This patient (Case 1) had a large recurrent direct and indirect hernia on the left side. b. A recent photograph made sometime after repair of the hernia and transference of the fascial flap.

fascia behaved in a manner similar to autogenous fascial grafts when incorporated in closures of the abdominal wall in dogs in that the ex fascia broke down and was digested. The consensus of opinion of those who have worked with heterofascial grafts is that they are replaced by tissue which invades the graft from the host. It is also to be remembered that catgut is essentially a heteroplastic graft, and its temporary survival is a matter of common knowledge. It should perhaps also be stated that there are those who contend that this is likewise the fate of free autoplasts, fascial grafts (25). The futility of the employment of homotransplants of skin and internal organs is now fairly well known (26). Relatively inert substances like bone and fascia however probably survive long enough to be adequately replaced by the tissues of the host.

CASE 1. Mrs. B. C. Hospital No. 5760, aged 32 years. The patient comes because of a tumor in the left lower quadrant of the abdomen which she has noted for the past few weeks. The mass is not tender. She states that 6 years ago an abortion occurred after 5 years of married life. Since then she has suffered considerable pain and distress, especially at the time of the menses. Three years ago the patient was operated upon because of pain in the lower abdomen at the time of the menses. A small cyst in one of the ovaries was found. Appendectomy was done at the same time. A year ago the patient had a normal pregnancy with difficult labor instrumental delivery. The child died the day after delivery. There is a machine supra-pubic scar. In the left lower quadrant of the abdomen there is a hard tumor mass attached to the abdominal

wall, apparently free from the dome. The mass appeared to be about 10 by 5 centimeters in diameter. Pre-operative diagnosis was probable desmoid of the abdominal wall. When the blow test is done, by having the patient close her glottis, hold her nose and try to exhale forcibly the tumor stands out prominently, indicating that it is probably within the abdominal parietes.

Operation was done February 9, 1931 under spinal anesthesia. An incision was made, and the tumor mass was found to be just beneath the external oblique aponeurosis involving the internal oblique muscle and the transverse fascia, as well as the lateral border of the rectus sheath. The tumor was widely excised, the transverse muscle in this region, together with the internal oblique muscle overlying it, being removed. A portion of the sheath of the rectus was also removed. It was reconstructed by suturing the two edges of the rectus sheath together again. After removal of the tumor it was apparent that no local sliding of tissues would permit of bringing the wound edges together. Incision was then made in the thigh and a large fascial flap of the distal third of fascia lata was turned up. This was led under Poupart's ligament and sutured to the external border of the rectus sheath. This afforded a good covering so that when the patient coughed there was no bulge of the peritoneum as there had been previously. No attempt was made to close the defect in the fascia of the thigh. The external oblique aponeurosis was sutured together over the fascial flap and both wounds were closed.

The operative convalescence was smooth and the patient left the hospital 15 days after operation. X-ray treatment having been given to the incision to obviate as far as possible recurrence of the tumor. Recent examination shows the abdominal wound in good condition (Fig. 4,c). There is no evidence of return of the tumor and there is no hernia.

CASE 2. Mrs. R. R. Hospital No. 6232, aged 53 years. In June 1921, the patient had an excision of tumor on

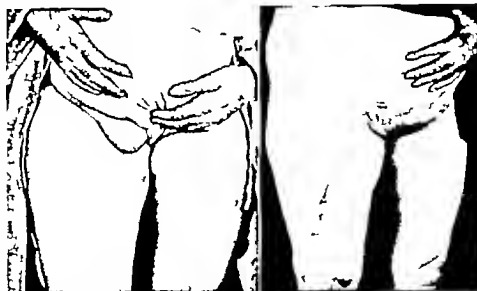


Fig 7 A left A woman with a recurrent femoral hernia with a large defect (Case 9) B, A recent photograph made sometime after the repair of the hernia by the transference of the iliotibial tract on the tensor fascia femora muscle

the lateral aspect of the abdominal wall which was then about the size of a lemon. The diagnosis was spindle cell sarcoma. About 3 months after excision the growth recurred and she was sent here for further therapy. The patient complains of a constant aching in the mass which lies just above the right iliac crest and is about 3 inches in diameter. The skin appears to move over it fairly freely though the scar is somewhat broad over it. X ray examination of the chest is negative for metastases.

On October 15, 1933 under nitrous oxide anesthesia the growth was excised. A long circular excision was made excising the vertical portion of the old scar. The tumor mass was found to involve the latissimus dorsi and its fascia, together with the external oblique aponeurosis, a good portion of the internal oblique and transversalis fascia. In other words, the tumor involved the entire abdominal wall at its lateral aspect. The fascia covering the medial aspect of the ilium seemed to be attached to the tumor. Superiorly the fascial involvement appeared to go as high as the twelfth rib. After the skin was undercut anteriorly and posteriorly the muscles of the abdominal wall were cut wide of the tumor. By means of a hammer and chisel about $\frac{1}{4}$ inch of the iliac crest was chiseled away so that the fascia on the inferior aspect of the tumor was widely removed. After completion of this dissection there was a wide defect in the lateral abdominal wall. The abdominal viscera were covered only by the peritoneum, through which coils of small intestine and the ascending colon could be well visualized. When the patient strained, the intestines bulged into the wound. The greater portion of the twelfth rib was uncovered in the dissection above, the dissection being carried as high as the eleventh rib. It was apparent that no local sliding of tissue was adequate to close this wound. The lower part of the incision was then extended almost to the knee, and the iliotibial tract swung on the tensor fascia lata muscle or a base was used to close the defect. The superficial side of this fascial flap was brought in contact with the peritoneum, the flap being tunneled beneath Poupart's ligament below the anterior superior spine. This fascial flap was then sutured to the remaining fibers of the transversus abdominis and internal oblique muscle posteriorly and superiorly anteriorly the fascial flap was sutured to the external oblique aponeurosis

and inferiorly to the iliacus fascia just medial to the ilium. A very satisfactory closure was obtained by this means. Interrupted subcuticular stitches were placed in the subcutaneous tissues and several Michel clips were placed in the skin. A Penrose drain was left at the superior margin of the wound.

The patient convalesced uneventfully and was permitted to be up 14 days after operation, at which time the wound was well healed. Postoperative X ray irradiation was also given (Fig 5).

CASE 3 Mr F Z., Hospital No. 68038, aged 57 years. An obese male presented himself with a huge hernial swelling in the right thigh and groin, the latter swelling extending into the scrotum. There was also a hernia on the left side for which the patient wore a truss, but it did not afford him as much trouble as the hernia on the right. The hernia on the right had been present for 33 years, during which time three operations for its repair have been done by competent surgeons, each time there has been prompt recurrence. The hernial mass could be reduced when the patient lay supine. There are scars in both inguinal regions.

Operation was done April 20, 1931 under spinal anesthesia. The old scar in the groin was excised. There was a deficiency in Poupart's ligament extending from about its middle portion to the pubic tubercle. There was virtually therefore both a direct inguinal and a femoral hernia present. The spermatic cord was not visualized and the testis was not identified in the scrotum. It probably had been extirpated at a previous operation. After the external oblique aponeurosis was incised, opening was made directly into the hernial sac, which was found to contain a good deal of fatty omentum which was excised. The bladder formed the medial wall of the hernial sac. It was freed up and pushed back into the extraperitoneal space. The broad hernial sac was then sutured across, much in the manner as one closes a vertical abdominal incision. The conjoined tendon was quite deficient. What little remained of the conjoined tendon was approximated to Poupart's ligament by interrupted mattress sutures. The lateral leaf of the external oblique aponeurosis was then approximated over the conjoined tendon. A vertical incision was then made in the thigh and a very broad flap of the iliotibial tract of

what enlarged to the left. Urine examination shows a trace of albumin and an occasional white cell cast, phenol sulphophtalein is 60 per cent. Electrocardiogram shows slight left ventricular preponderance. On November 13, 1931 under drop ether anesthesia the hernia was repaired. There was a marked protrusion of the abdominal wall through the old McBurney incision. The old scar was excised and several coils of intestine were found adherent to the abdominal wall. The gut was freed from the anterior abdominal wall. The peritoneum and rectus abdominis were mobilized in one layer. Because of the relative non-dependability of the tissues it was thought wise to assay the iliofascial tract of fascia up from the thigh, which was done in the usual manner. This fascial flap was sutured over the entire region of repair of the hernia. Interrupted sutures were placed in the subcutaneous tissues, linen was used in the skin. A very satisfactory repair was made.

The patient had some difficulty with the healing of the wound on the thigh. There was no evidence of infection. She was discharged from the hospital on December 30, 1931 and has remained well.

CASE 2. Mr. A. B. Hospital No. 63003, aged 33 years. Five years ago this patient was operated upon at another local hospital under the diagnosis of acute appendicitis through a low right rectus incision. The peritoneal cavity was opened and it was apparent that a perforation of a duodenal ulcer had occurred. The incision was then extended up to the umbilicus and the perforation was closed. The patient recovered from the operation but the wound became infected and the patient developed an enormous hernia through it. Entire extent extending practically from the pubis to the umbilicus. Through this incision the spleen could be palpated as well as the abdominal aorta through the greater portion of its course. He reports now for the repair of this enormous hernia because of its interference with and because of constant pain on exertion.

Operation was done May 1, 1932 under spinal anesthesia reinforced by ethylene oxide and the completion of the operation. The greater portion of the old scar was excised, the skin edges undermined, and the peritoneum was immediately cut down upon. The rectus muscles were widely separated. The omentum was detached where it was adherent to the anterior parietal wall. The bleeding point was ligated. A few interrupted sutures were placed more effectively to coaptate the separated structures. No attempt was made however in bringing the widely separated coils of the rectus muscles together. About ten or twelve interrupted sutures were placed approximating the peritoneum and the rectus fascia covering the rectus muscles in one layer. A long incision was then made in the thigh and a very long flap of the iliofascial tract was turned up which reached to the very top of the abdominal incision. This flap was sutured in its end and the wound was closed. He had a slight fever for the first few days after operation, the highest reading being on the third day after operation, viz. 101.5 degrees F. The patient was discharged when the wound healed, on the twentieth day after operation, and the hernia has remained well.

CASE 3. Miss G. C. Hospital No. 634175, aged 33 years. In 1925 this patient was operated upon elsewhere for the excision of her gall bladder and the appendix. After operation a large hernia developed in the operative incision. In January 1932 an attempt was made to repair this large hernial defect by employment of a flap of fascia from the left thigh. The patient had a stormy convalescence. Infection developed in the wound and the hernia continued to increase in size. During the past year she has had to remain almost constantly in bed because of

her disability and weakness. Attempts had been made to have the patient get out of bed, but, because of weakness, she was unable to walk unassisted. She was also quite anorectic, but reduced about 30 pounds on a low calorie diet. Neurological examination failed to show any evidence of any old anterior poliomyelitis, which might have been responsible for the weakness of the abdominal wall. The risk of operating upon this patient was fully appreciated. About 7 months elapsed from the time of first seeing the patient until I consented to operate upon her.

Operation was done under spinal anesthesia on February 9, 1933. The old scar was excised through an elliptical incision. Intestines, colon, and stomach were entirely subcutaneous due to wide retraction of the rectus muscles. The greater portion of the great omentum was cut away and the intestines were dropped back into the free peritoneal space. The rectus muscles were widely separated but of fair substance. A good portion of the liver protruded into the wound. There were no unusual intraoperative findings. About twenty interrupted sutures of chromic catgut were used to approximate the rectus muscles. Approximation was difficult. A number of interrupted sutures had to be resupplied to bring the structures in contact. A running suture of chromic 40 day catgut was put over them. The iliofascial tract was brought up from the thigh over Propert's ligament to cover the approximated tissues. I felt on completion of the operation that a very satisfactory closure had been made. The incision in the right thigh extended practically to the knee. Both wounds were closed with Michel clips. Twenty-four hours after operation, her temperature went to 101.5 degrees F. The patient became stuporous and died 48 hours after operation. A nasal tube had been put down before operation to reduce the anoxic condition. Hemorrhagic encephalitis was found and it was thought that fat embolism was the cause of death.

CASE 4. Mrs. M. S. Hospital No. 634493, aged 44 years. The patient had had two previous operations elsewhere. In 1923 she had a cesarean section through a left rectus incision. About 4 years ago she had the gall bladder removed through an incision made parallel to the costal margin. A hernia occurred in the gall-bladder incision and a year ago an operation was directed at its cure. It failed and there was prompt recurrence. The patient presents herself now with a tremendous hernia in the gall-bladder incision and also a large defect in the upper end of the left rectus incision. Because of the patient's general status and weakness it was believed wise not to undertake the repair of the hernia. It had been described as an inoperable hernia. The patient's incapacity is such, however, that she cannot work because of the hernia and she was anxious to have it repaired.

On March 20, 1933 under spinal anesthesia reinforced with ethylene gas toward the end of the operative procedure a repair of these hernias was done. The main hernial sac in the old gall-bladder incision lay immediately beneath the skin. When it was uncovered it was found that the other defect was just a web to the left of the most medial portion of the large defect. After the contents of the large hernial sac on the right had been replaced in the peritoneal cavity it was thought wise to divide the tissue between these two hernial orifices and to deal with them as one hernia. A fairly satisfactory closure of the defect was obtained by a series of interrupted sutures. Because of the inherent weakness of the tissues it was felt best to make an incision in the thigh and bring up the iliofascial tract as a flap which was done anterior to the Propert's ligament, tunneling beneath the skin. The apex of the flap was brought to the upper part of the incision on the right, but it was not broad enough to cover the left

hernia. A few days after the operation, the patient developed a rather serious wound infection in the right thigh, and ran a high fever for a considerable period of time. It was thought that the contamination of the wound occurred through the use of a sand bag employed to tilt the thigh which had previously been used in a septic operation. (The custom had been to wash these sand bags off with antiseptic solution. Since this time, however, we have made it a routine practice to autoclave these sand bags, after they have been used.) The dressing had become soaked with blood during the operative procedure and the sand bag perhaps had contaminated the dressing. After a long period of time under Dakin's irrigation the wound cleared up.

This patient was dismissed from the hospital well and the wound healed by July 5, 1933. The large hernia in the gall-bladder incision apparently is cured. In the hernia to the left of the midline in which fascia was not used because the flap was not broad enough there is a suggestion of a recurrence.

CASE 14. Mrs M. C. Hospital No 604032, aged 51 years. This patient comes because of a large incisional hernia on the right. She has had 16 pregnancies and has given birth to 7 children. The hernia followed an incision made 12 years ago when she was delivered by caesarean section for eclampsia. About 25 years ago she had a previous operation through an incision at the same site for the removal of her appendix and right tube. The bulge in the incision occurred shortly after the caesarean section was done and it slowly increased in size. In the last 5 years there has been a large protrusion. When the patient stands there is a test-like process at the lower end of the incision through which the intestine protrudes. The separation in the wound runs the entire length of the wound from the pubis to just opposite the umbilicus. The separation is several inches in width. There is a small lipoma in the left labia. Otherwise the physical examination is negative.

Operation was done on November 17, 1933 under spinal anesthesia which was reinforced toward the end of the operative procedure by the administration of ethylene. A vertical incision was made excising the old scar. The intestine was found to lie immediately beneath the skin. There was wide retraction of the rectus muscles. The small intestine was adherent to the sac in a couple of places, and when the skin was detached from the gut, the gut was partially denuded at one place necessitating inversion by a pursestring suture. There were no unusual intra-abdominal findings. Many interrupted sutures of chromic catgut were placed approximating the rectus muscles. A small flap was left on the right, consisting of adventitious tissue which had constituted the peritoneal lining of the hernial sac. The right flap was pulled over the left. When these sutures were tied, however, a good portion of the right flap was cut away because it was not deemed to be of much value. What little remained was tacked down upon the external oblique aponeurosis on the left. The fat was widely under-cut. Because of the weakness of the tissue and insecurity of the closure, it was felt wise to swing up the iliothoracic tract of fascia from the right thigh. This fascial flap was then tunneled beneath the skin over Poupart's ligament and tacked over the site of previous hernioplasty. The incision in the thigh was shorter than it should have been and because of the patient's short stature it scarcely reached to the top of the incision. An extra strip of fascia lata was then cut and was imbricated superiorly over the site of closure. Subcutaneous sutures of catgut were employed to approximate the subcutaneous tissues and obliterate the dead space. Michel clips were placed in the skin. The lower wound was similarly closed after obtaining adequate haemostasis. Small Penrose drains were left in

both wounds. The patient convalesced uneventfully save for somewhat prolonged drainage from the abdominal incision.

SUMMARY AND CONCLUSIONS

A method for the repair of difficult hernias and large defects of the abdominal wall is presented through the employment of the iliothoracic tract of fascia as a flap pedicled on the tensor fasciae femoris muscle. This muscle may be swung upward with its nerve and blood supply preserved intact. The transference of this musculotendinous graft may be easily made and its loss to the thigh does not compromise any function which it ordinarily performs. In the repair of large defects of the abdominal wall in which the loss of tissue precludes approximation, this pedicled graft is best drawn beneath Poupart's ligament with the superficial or fatty side down and sutured into the defect. In the repair of hernias, it is best brought up over Poupart's ligament and incorporated in the closure, the flap being slightly rotated at its base so that the superficial or fatty side remains up.

In difficult recurrent inguinal or femoral hernias, this flap of fascia may be intimately incorporated with the suture of the adjacent tissues. In the repair of incisional hernias, the flap is best sutured as a patch over the site of closure, it being anchored securely to the normal adjacent fascial structures.

In the use of this strong sheet of fascia pedicled on a muscle whose blood and nerve supply remains preserved, one has available a simple but effectual and practical method for the mending of difficult hernias and large abdominal defects, which meets all the requirements demanded for ideal tissue transference.

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DRAINAGE OF THE COMMON BILE DUCT FOR GALL STONES

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IN 1921 Reid and Halsted (3) reported a method of draining the common duct through the stump of the cystic duct following cholecystectomy, a procedure to which they gave the name cysticocholedochostomy. At that time it was pointed out that by this method the amount and duration of the external drainage of bile were considerably less than in those cases drained in other ways. This is due to several factors which may be enumerated. First, the opening made in the common duct can be closed completely and securely with two rows of sutures. The absence of a foreign body (the drainage tube) at this line of suture predisposes to more benign healing of the incision. It should heal *per primum* with very slight scarring of the duct. Second, the tube emerges from the duct through a long narrow channel, so that it remains water tight and there should be no leakage of bile into the wound. Third, the removal of the tube does not disturb the incision in the common duct, and leaves a long narrow tract which tends to heal very quickly.

The method can be carried out only after removal of the gall bladder and in instances in which the cystic duct is not occluded and can be dilated sufficiently to permit passage of the drainage tube through it. In those cases in which on account of debility or extreme jaundice it seems advisable to explore the common duct and relieve the obstruction to it first, the method may not be applicable. Reid and Halsted believed that in most cases it was desirable to remove the gall bladder and in this clinic the routine has been to remove the gall bladder first and then to explore the common duct as this is technically easier and in practically all cases with stone in the common duct, the gall bladder is so diseased that it should be removed. It seems to us that the argument for leaving the gall bladder as a possible channel to carry the bile to the intestinal tract in case of injury or damage to the common bile duct is not valid for in our experience in the cases in which it would be most needed, the gall bladder has been so modified by disease as to be valueless as a biliary channel.

While the method of draining the common duct through the stump of the cystic duct is undoubtedly widely used it is not as universally popular as is the use of a T tube to judge by the

methods described in textbooks of surgery. Cysticocholedochostomy seems to offer definite advantages over other methods and should be more widely used. In this connection it should be emphasized that incision of the common duct through the stump of the cystic and insertion of the tube through this opening, followed by suture, does not have the advantage of allowing the tube to emerge away from the suture line as it does in the technique devised by Reid and Halsted.

Their method has been used for a number of years as the routine procedure for drainage of the common bile duct at the Cincinnati General Hospital and we wish here to report the experience with it at this institution. The technique which is used is as follows. After removal of the gall bladder, an incision is made in the common bile duct about 1 centimeter below the entrance of the cystic duct, for exploration or removal of stones. The edges of this incision are held open by traction sutures of fine silk. This is much better than the use of Allis clamps or forceps as there is less trauma to the duct. After the stones are removed and it is demonstrated that the common duct is patent into the duodenum and into the hepatic ducts, a small catheter is inserted through the stump of the cystic duct into the common duct (Fig. 1). The size of this catheter depends on the diameter of the cystic duct, usually a No. 12, 14, or 16 French being used. It should fit snugly in the cystic duct. Several holes are cut in its sides near the tip, but the rounded tip itself is not cut off. This catheter is directed downward in the common duct toward the ampulla, and its position can be directed through the incision in the common duct. With a very small cystic duct it may be easier to pass the tube into it through the opening in the common duct. A small probe can be passed first, a stout thread tied to it and pulled through, and the catheter pulled through by means of the thread. After the tube is properly placed, it is fixed in position by a suture of fine plain catgut, it being tied tightly to the stump of the cystic duct. The incision in the common duct is then closed with a continuous suture of fine plain catgut. This may be inverted and reinforced with a row of interrupted fine silk sutures (Fig. 2). Several cigarette drains are placed near, but not against, the line of suture,

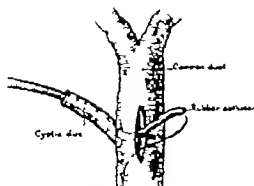


Fig. 2. The small side openings are made in the catheter after it has been introduced through the cystic duct and pulled out of the opening in the common duct. It is then returned to the common duct and anchored to the cystic duct before the incision of the common duct is closed. In this way one assures the final position of the end of the catheter.

and the abdomen is closed. The catheter is fastened to the dressings and its free end is placed in a bottle strapped to the patient's side.

The amount and character of the biliary drainage is charted twice daily by the nurse. When the drainage becomes scant in amount, either the bottle is elevated so as to increase the pressure in the catheter or the tube is clamped off for a period of hours. If the closure around the tube is tight and the incision in the common duct has healed there will be no drainage of bile around the tube. If the common duct is still partially obstructed by edema or for other reasons, pain will occur when the tube is clamped or elevated. On the other hand, with the tube clamped or elevated and no pain, and no drainage of bile through or around the tube, we can be sure the bile is entering the duodenum. We regard elevation of the tube as better than clamping to cause increase of the pressure in it and in the bile ducts. A technique for this procedure was described by Reid (2) in 1923. After drainage from the tube ceases, the tube may be removed and it is almost certain that there will be little or no drainage of bile from the wound, and that it will soon heal.

In this clinic the common bile duct is not opened and explored routinely in all cases in which the gall bladder is removed, but it is always examined by palpation although it is appreciated that, as Lahey and others have pointed out, a stone may be overlooked in this way. The common duct is explored when a stone is felt in it, when there has been jaundice present before operation or a history suggestive of stone in the common duct. It is also explored if it is dilated or its wall thickened. In some instances

in which the caliber of the cystic duct is large it has been possible to pass a probe through the stump into the common duct and on into the duodenum without incision of the common duct itself though this is not recommended as it may lead to undue trauma and inaccurate information. Following such a procedure, drainage is usually instituted for fear edema may occlude the common duct following the manipulation.

In some cases drainage of the common duct through the stump of the cystic duct is not possible due to the complete obliteration or the small caliber of the cystic duct. It is necessary in many cases to dilate the cystic duct with a clamp or a special dilator before even the smallest catheter can be inserted. When this is not possible we advise the use of a catheter directed downward in the common duct which is inserted through a small stab wound in the duct separate from the exploratory incision, and then complete closure of the latter incision (Fig. 3).

During the past 9 years at the Cincinnati General Hospital, there have been 42 cases in which the records were complete and in which the common duct was drained through the stump of the cystic duct. The common duct was incised for exploration in 24 cases, and in the 18 remaining cases the common duct was probed for obstruction through the stump of the cystic duct. The opening in the common duct was closed tightly with catgut in 1 case with silk in 10 cases, and with catgut and silk in 13 cases. The differences in technique are undoubtedly due to the fact that a number of different surgeons operated upon the patients. Of the 42 cases, 38 are available for study; the 4 remaining patients having died.

The total number of days in hospital after operation for the 38 cases was 1074, an average of 28 days per case. The longest hospital stay after operation was 118 days, and the shortest 14 days. In the first of these cases a persistent biliary fistula has developed, most likely due to failure to remove all of the stones in the common duct but since the patient is fairly comfortable, and his age and general condition are such that further operation would be decidedly dangerous, he has not been operated upon again. This is the only case of persistent biliary fistula in this series.¹ It was found that there was considerable variation in the length of time that the tube was allowed to remain in the duct. The tube was removed on

¹ Because of progressive intractable anasthesia operation was postponed year later. A large, solitary stone was removed from the common duct. The stump of the cystic duct was ligated, and catheter inserted through it into the common duct. This tube was removed on the seventh day; drainage of bile ceased on the tenth day. The patient has been quite well ever since.

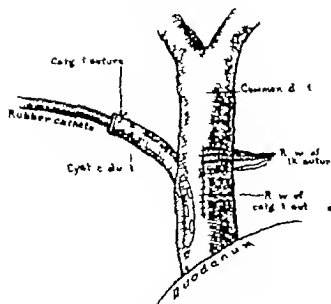


Fig. 2. Cysticocholedochostomy completed except for the second row of sutures in the common duct

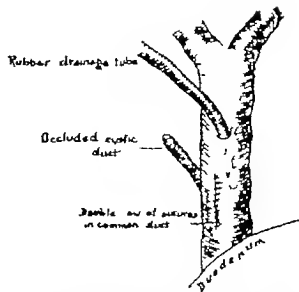


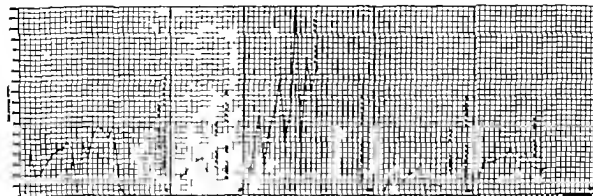
Fig. 3. Method of avoiding the placing of a tube through the location of the common duct when a cysticocholedochostomy cannot be done.

the eleventh day in the greatest number of cases and ordinarily drainage from the wound ceased within 4 days. The longest time that a tube was allowed to remain in place was 27 days and the shortest was 7 days. In the first of these the drainage had ceased by the twenty third day and as there was no reason in the record why the tube was allowed to remain in place one can only speculate as to the real reason. It is possible that the drainage was allowed to continue because of the pancreatitis that was found at the time of operation. It has been suggested by numerous authors and in some clinics it is a routine procedure, to drain the common duct over a long period of time in cases of pancreatitis. In this clinic such a procedure is not routine, and the time for the removal of the tube depends usually on the reaction of the patient with reference to the decreasing icterus and the decrease in the amount of external biliary flow. The experience with this case indicates that prolonged drainage of the common bile duct can be carried out by this method if it is desired. The drainage of bile in this case which varied from 60 to 650 cubic centimeters per day may be seen in Chart I. The drainage through the tube ceased on the twenty third day the tube was removed on the twenty seventh day and the patient was discharged 30 days after operation, with the wound almost completely healed. In the other case the drainage tube was removed on the seventh day and all drainage of bile had ceased by the twelfth day. The amount of bile drainage which varied from 180 to 380 cubic centimeters per day may be seen on Chart II. The patient was discharged

on the fifteenth day in excellent general condition with the wound completely healed.

In this series of cases there was also found to be marked variation in the quantity of bile which drained through the tube. In one case a total of 11,030 cubic centimeters of bile was collected in the 14 days the tube was in place the largest amount in any 24 hour period being 1800 cubic centimeters on the tenth day (Chart III). In contrast to this in another case the total drainage in 14 days was 1580 cubic centimeters the maximum amount in one day being 280 cubic centimeters (Chart IV).

The average daily drainage of bile is shown in Chart V. The amount of drainage in every case was not noted on the record for every day. To obtain the averages shown in this chart, only the quantities of bile that were recorded were taken into account including, of course those cases in which no drainage was reported. At the bottom of the chart can be noted the number of cases which entered into each day's calculation. It is realized that this method of arriving at an average is inaccurate but the figures are probably the best that could be reached from the available data. This chart shows that the smallest average amount of bile (110 cubic centimeters) drained on the day of operation and the largest amount (450 cubic centimeters) on the seventh day. There was a rapid rise in amount from the first to the second day, then a slower increase to a peak on the seventh day. From the seventh to the tenth day, there was a slow drop, followed by a considerable drop on the eleventh day which was the average time at which the tube was



Charts showing the amount of bile collected through the drainage tube on successive days. I The drainage of bile in the case in which the tube remained in place for the greatest number of days. II The drainage of bile in the case in which the tube remained in place the shortest time. III, Chart of the patient who showed the greatest total

drainage of bile through the tube. IV, Chart showing the smallest amount of drainage of bile of any patient in this series. V Chart showing the average amount of drainage of the bile for all the cases. The number of patients entering into each day's calculation is shown in the lower line of figures.

removed. Drainage of bile from the wound after removal of the tube ceased in 2 to 4 days as a rule, though here again the exact time was not given definitely on the records in a sufficient number of the cases to allow exact computation. For example, the record might show that bile was draining the day after removal of the tube. The next note several days later might state that bile drainage had ceased, but not the day on which it had ceased. It was unusual for bile to continue to drain more than 7 days after removal of the tube.

A careful study of the records with regard to the temperature curves reveals that the highest pre-operative temperature was 103.8 degrees occurring on the day of operation. The maximum postoperative temperature was 103.6 degrees and occurred on the sixth day. The removal of the tube did not affect the temperature curve in any manner nor did it affect the general condition of the patient.

In the series of 48 cases, 4 died—a mortality rate of 9.3 per cent. Autopsies were obtained on 3 of them. One of these died of pneumonia on the sixth day; another of acute hemorrhagic pancreatitis, also on the sixth day. In the 2 remaining cases there was extensive infection with abscess formation present. In both cases the gall bladder was removed in spite of the presence of the marked infection. As the records of these 2 cases are reviewed, one questions whether the patients might not have survived if a less radical surgical procedure had been carried out at the time of this operation, perhaps drainage of the common bile duct alone, or better, of the gall bladder if that would have sufficed to drain the common duct.

A study of 12 patients who were operated upon during the same period of time as the above series, in which it was impossible to drain the common duct through the stump of the cystic duct, revealed the following facts: (1) The most common cause for inability to drain through the cystic duct was the small caliber of the duct. (2) The drainage of bile through the wound was longer following removal of the catheter. The average was 18 days, the shortest 4 days, and the longest 90 days. (3) There was considerable drainage of bile around the drainage tube onto the dressings. (4) The hospitalization period was longer due to the protracted biliary drainage and the subsequent failure of the sinus tract to granulate and heal. (5) The mortality rate was higher (25 per cent) although this may be partially discounted because the series is smaller and the cases in general were poorer operative risks with more marked pathological change.

DEDUCTIONS

The method of drainage of the common bile duct through the stump of the cystic duct has proved highly satisfactory and is in our opinion the method of choice where drainage of the duct is indicated. It was rather a surprise to find that in this small series such a relatively large proportion of the cases had had the common duct explored through the cystic stump. We do not recommend this procedure as it may lead to undue trauma to the duct, and to inadequate exploration. In addition, there is really no contra-indication to incision of the common duct when exploration is necessary for when drainage is done by this method the incision can be closed

completely and accurately by suture, and usually heals *per primam*.

The only serious drawback to the routine use of cysticocholedochostomy is the necessity of removing the gall bladder at the same operation. Thus we believe is an advantage provided the patient is able to stand the entire operation, as the convalescence is shortened and no secondary operation is necessary. The procedure should not be done on patients whose general condition is so poor that only the least amount of operative work is warranted. In such cases, drainage of the gall bladder or common duct, often without removing any stones, should be done with the idea of carrying out a completed operation later when the patient's general condition has improved. Several of the deaths in this group were probably due to too extensive procedures at one stage. If the gall bladder is not removed, we believe that drainage of the common duct should be instituted through a small catheter directed downward in the common duct, and inserted into it, if possible, through a separate stab wound so as to allow complete and accurate closure of the incision through which exploration has been done. In none of our cases was a T tube used for drainage and we see no justification for the use of this type of tube for it seems obvious that the wound produced by the removal of it is as large or nearly as large as the original incision. We also see no advantage in incising the cystic stump and continuing the incision into the common duct, and then allowing the drainage tube to emerge through the cystic duct. While this gives a long narrow channel for the drainage tube and allows removal of the tube to be easily accomplished, it does not keep the tube away from the line of suture which is one of the major objectives of the method of Reid and Halsted. Finally, there seems to be no justification for closing the common duct tight with no drainage after it has been explored. The method described is so simple, easy, and safe that one should not run the risk of a possible extravasation of bile into the peritoneal cavity in the absence of a drainage tube.

SUMMARY

Records of 42 cases of drainage of the common duct through the stump of the cystic duct were reviewed. Four of the patients died. In the 38 remaining cases the total number of postoperative hospital days was 1074, an average of 28

days per case. The longest postoperative stay was 118 days, shortest, 14 days. The longest time the tube was kept in the duct was 27 days, the shortest 7 days, the average 11 days. Drainage of bile from the wound usually ceased within 2 to 4 days after removal of the tube and rarely continued for more than 7 days after the tube was removed. The total and the daily drainage of bile varied considerably in different individuals. In general it was least on the day of operation, increased to a maximum on the seventh day, and then decreased slowly until the eleventh day, after which time it ceased rather abruptly.

Records of 12 cases of drainage of the common duct through the exploratory incision were also reviewed. Three of these patients died. In the 9 remaining cases the total number of postoperative hospital days was 378, an average of 42 days per case. The longest time the tube was kept in the duct was 14 days, shortest 9 days, average 11 days. In almost every case there was leakage of bile around the tube before it was removed. Drainage of bile from the wound after removal of the tube usually continued for 10 days to 2 weeks, and in 1 case it continued for 90 days.

CONCLUSIONS

Drainage of the common duct through the stump of the cystic duct should be the method of choice when drainage of the duct is necessary. It allows complete and accurate suture of the exploratory incision which predisposes to early firm healing of this incision with minimal scarring. It provides a long narrow channel for the drainage tube which ordinarily remains water tight until it is time to remove the tube. Removal of the tube causes very little damage or disturbance to the common duct, and drainage of bile from the wound after removal of the tube is of very short duration. The method therefore reduces the total loss of bile and shortens materially the duration of the convalescence.

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PARTIAL GASTRIC FUNDUSECTOMY IN TREATMENT OF PEPTIC ULCER

F GREGORY CONNELL, M.D. F A.C.S., OROLOGO, WISCONSIN

A REVIEW of editorials in recent literature (1) emphasizes the conflict of opinion regarding the etiology and the treatment of peptic ulcer.

Partial fundusectomy (aiming at a diminution of the acid secreting surface rather than the removal of the alkaline secreting, ulcer bearing area²) was presented (2) as a compromise between gastro-enterostomy and subtotal gastrectomy the former considered by some as not radical enough and the latter by many as too radical.

Partial fundusectomy permits a retention of the important antro-pyloro-duodenal mechanism.

The indications for such procedure are: peptic ulcer of the duodenum; peptic ulcer of the stomach (because of potential malignant change, to be supplemented by local resection); peptic ulcer of the jejunum, after gastro-enterostomy. Organic pyloric obstruction calls for additional operation.

The technique is simple.

After the abdomen is explored and proper indications for the procedure are established, the stomach is delivered and the general peritoneal cavity is walled off.

The omentum is separated with careful hemostasis, from the middle third (the usual site and extent of the partial fundusectomy) of the greater curvature.

A double wedge-shaped section of both the anterior and posterior fundal walls with a common base at the middle third of the greater curvature is removed; the two incisions meeting about 1 inch below the lesser curvature on both anterior and

posterior walls. After proper pre-operative management, the stomach should be empty and as hyperchlorhydria is usual, the contents are comparatively sterile. Non-use of clamps will permit accurate hemostasis and careful examination of the interior of the stomach.

A holding forceps is applied at the apex of the triangle in the posterior gastric wall, and another forceps is used to approximate the divided greater curvature. Traction on these forceps brings the posterior wall into apposition suitable for hemostasis and suturing.

The posterior wall from the upper lesser curvature, to the lower greater curvature, is repaired with through-and-through (mucosa to mucosa) catgut sutures. The reconstruction of the stomach is completed by closure of the anterior wall from the lower greater curvature to the upper lesser curvature by continuing the suturing with over and over (seroserous) sutures (Fig. 1).

The attaching of the greater omentum to the mimimized greater curvature completes the operation and the abdomen is closed without drainage.

The management after operation will be the same as is customary after any other type of stomach operation.

Clinical results, to date, following this operative procedure are reported in Table I. All except the first case are too recent for consideration of the remote result, but in Case 1 which was considered intractable, a follow up after 2 years shows a satisfactory i.e. symptom free result a fact which would suggest a definite field of usefulness for par-

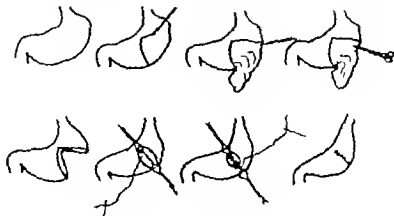


Fig. 1. Partial gastric fundusectomy.

TABLE I—CLINICAL RESULTS

No. Name Age Sex	Family history	Previous history	Chief complaint	Physical examination and laboratory findings	X-ray and diagnosis	Date operative findings	Result
1 H. P. M	Father Gastric ulcer Mother gall stones Brother (1) Gastric ulcer perforated (2) Gastric ulcer medical treatment Sister Gastric ulcer two operations, symptoms persist Referred by Dr. T. D. South, Neeah, Wis.	Remission Tuberculosis Rheocarditis 90 Appendectomy 1908 Duodenal ulcer perforated, gastro-enterostomy 1930 Duodenal enterostomy	Typical symptoms of peptic ulcer	Nodular goiter Leucocytosis Gastric acid high	Deformed duodenal cap Pylorus patent Duodenal ulcer recurrent	12-14-31 Duodenal ulcer no obstruction	6-19-32 Symptom free
2 S. S. M	Negative Referred by Dr. J. P. Schander, Oaklamb, Wis.	920 Appendectomy 1913 Gastro-enterostomy for duodenal ulcer 1918 Hemorrhoidectomy	Seasickness Food case Nervous	Heart murmur Leucocytosis Gastric acid high	Duodenal cap not reached Pylorus patent Filling defect at stomach Jejunal ulcer after gastro-enterostomy	27-12-31 Jejunal ulcer at gastro-enterostomy	Death the 14th day postopera live Pulmonary embolism
3 A. D. M	Father Gastric ulcer Referred by Dr. V. Marshall, Appleton, Wis.	920 Appendectomy and gastro-enterostomy for duodenal ulcer 1916 Hemorrhoidectomy and hernia 1918 Transfusion 1919 Chronic bleeding with symptoms of jejunal ulcer	Symptoms of jejunal ulcer with weakness and anemia	Negative Gastric acid high	Filling defect at stomach Jejunal ulcer after gastro-enterostomy	2-15-32 Jejunal ulcer at gastro-enterostomy	Feb. 1932 Symptom free
4 F. B. M	Negative Referred by Dr. C. J. Connel, Oaklamb, Wis.	95 Appendectomy Cholecystectomy and omentectomy 1926 Recurrence of symptoms 1931 Persistent diarrhea, "burning"	Acid stomach burning No food case	Negative Gastric acid high	Deformed duodenal cap Pylorus patent Duodenal ulcer	6-10-31 No ulcer demonstrated, "gastritis"	Mar. 1932 Burning in stomach
5 J. C. M	Negative Referred by Dr. H. Muesel, Oaklamb, Wis.	Previous attack 20 yrs ago	Pain, nausea, gas, food case Onset at 37 sudden	Negative Gastric acid high	Deformed duodenal cap Pylorus patent Duodenal ulcer	8-16-31 Duodenal ulcer no obstruction	Apr. 1932 Symptom free
6 M. C. F	Negative Referred by H. F. Weidender, Royal Infirmary, Liverpool, England	years duration Pain, nausea, vomiting loss of weight	years duration Pain, nausea, vomiting loss of weight	Negative 000	Penetrating ulcer lesser curvature Pylorus patent Gastric ulcer	11-29-31 Fundusctomy with excision of ulcer	11-24-32 Symptom free
7 P. T. M	2 sisters Ulcer of stomach	1917 Appendectomy 1920 Symptoms of peptic ulcer 1931 acute hematocytosis	Gas pain qualitative food distress Food and soda case Seasonal variation	Blood pressure low Gastric acid high	Deformed duodenal cap No pyloric obstruction Duodenal ulcer	1-18-32 Duodenal ulcer	6-17-32 Symptom free

tial fundusectomy in suitable cases of peptic ulcer

The postoperative history in Case 1 follows

March 15, 1932 he had gained 3 pounds in weight and was symptom free, and has remained so to date. Test meal shows free hydrochloric acid absent, total acid 37 June 23, 1932 free hydrochloric 18 total acid 52.

August 30, 1932 free acid 33, total acid 40. Barium meal showed duodenal cap irregular with no 6 hour retention. There is present a very slight irregularity at the greater curvature.

May 1, 1932 by letter symptom free.

October 9, 1932 by letter, at work symptom free

November 24, 1932 by phone at work, unable to come for test meal and barium check up

The only medical treatment or "management" has been frequent small feedings of general diet, with omission of salt.

In addition to the 6 clinical cases mentioned, the following personal communications bearing upon the experimental aspect of this subject are appended.

Professor A. C. Ivy of Northwestern University Medical School on November 29, 1933, writes

"In studying the effects of total fundusectomy on the occurrence of jejunal ulcer we followed this plan. Approximately 75 per cent of the fundus was removed by a 'wedge' operation then 2 months later a Mann-Williamson operation was performed. We then followed the dogs closely for the clinical evidence of the development of ulcer and checked by autopsy gastric analyses being made from time to time. We have operated upon 20 dogs. The results indicate that fundusectomy delays the development of jejunal

ulcer in these dogs. The acidity of the gastric contents is decreased at first, but later returns to normal in those dogs that develop hypertrophy of the stomach. When we compared the results obtained from the 12 dogs—experiment complete—with a "time of ulcer occurrence curve" constructed from results on 40 control dogs, we observed a prophylactic delay value of about 60 per cent. If we could satisfactorily control the nutritional factor in these dogs, we believe that the results would be better except in those dogs that continue to bolt their food and show much hypertrophy of the gastric remnant."

Professor Frank C. Mann, of the Mayo Foundation at Rochester, Minnesota, on December 5 1933, writes

"In regard to our work on partial gastric fundusectomy I wish to state that the work was done by Dr. Watson, who followed out the acidity and pH of the gastric contents before and after removal of various portions of the fundus. In his immediate results his work corroborated your experi-

ments, namely that there was a decrease in acidity roughly paralleling the amount of the fundic mucosa removed; however the acidity returned to normal within a few months' time after operation in almost all of the animals studied. We have not been able to determine one phase of the subject in which I am interested, namely the effect of partial gastric fundusectomy upon the total amount of gastric juices secreted. I am inclined to believe that if there were any permanent clinical results it would be more on the basis of actual reduction of the amount of gastric juice and therefore acid produced, than any change in regard to the degree of acidity."

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SUBPHRENIC ABSCESS IN CHILDREN¹

JAY IRELAND AND CHICAGO

JUDGING from the reports in the literature subphrenic abscess in children is quite rare.

Because of this it was thought that a report in detail of 6 cases occurring in childhood would be of unusual interest. This disease entity was first described by Barlow in 1845.

Of Gatewood's 41 patients all were adults except one who was a child aged 8 years. However, Brown reported 4 cases under 10 years of age and one of these was only 12 months of age. The ages of the cases here reported range from 14 months to 12 years. Two were males and 4 were females.

Most subphrenic abscesses follow an infection elsewhere in the body. Elkin stated that in approximately 6 per cent of all cases of suppurative appendicitis, an abscess develops beneath the diaphragm. Of Ochsner's 84 cases 35 per cent and of Gatewood's 41 cases 26 per cent followed appendicitis. Their series were composed chiefly of adults, while in this series made up entirely of children 4 (66 per cent) followed acute appendicitis. Of Gatewood's cases 34 per cent followed stomach or duodenal lesions while only 1 (24 per cent) followed a ruptured gastric ulcer in the present series.

Two of Ochsner's and Graves' 5 cases and 1 (16 per cent) in the present series followed pneumonia but none of Gatewood's cases followed this disease. Cases of subphrenic abscess have been reported following perforations of the stomach, duodenum, appendix, gall bladder also following primary diseases of the liver, bile passages, lung, esophagus, kidney, pancreas, spleen, spine, rib diverticula following pelvic infections and pelvic fractures. They have also followed pyæmia and distant infections. Aynesworth's case followed a liver abscess in which drainage was instituted and numerous cases have followed rupture of a liver abscess (Roesner, Rácz, Harrington, Schwartz). Kuru reported a case following splenectomy.

Schwartz stated that the most common types of organisms present are streptococci, staphylococci, colon bacillus and not infrequently, amœba. Scott reported 1 case due to gonococci and said he was unable to find any other similar case in the literature. Graves and Ochsner reported 2 cases due to actinomycosis and found a total of only 8 other cases reported in the literature.

Cultures of the pus obtained from the subphrenic abscess at the time of operation in Case 1

of this series showed *Bacillus coli*, Case 2 *Staphylococcus aureus* and *Streptococcus mitior*, Case 3 *Bacillus coli*, Case 4 *Streptococcus hemolyticus*, Case 5, *Bacillus coli* and anaerobic coccus and Case 6 non hemolytic streptococcus. Culture of the pus obtained from the abdomen at necropsy in Case 2 showed *Bacillus coli*, *Streptococcus viridans*, and an organism resembling *Klebs-Loeffler bacillus*. The last named organism was considered to be a contamination. From this summary it is noted that there is no uniformity of organisms present.

The different locations of the abscesses have been stressed by many observers and need not be repeated here. In the present series 4 were on the right side and 2 on the left. The abscess was located between the liver and the diaphragm in the 4 cases in which the abscess was on the right side. All were thought to be intraperitoneal.

Ochsner believed that less than one half of subphrenic infections lead to suppuration. Even when fluid is present, in some instances it may be serous and not progress to pus formation. As to the manner of formation, some of the abscesses are thought to be primary, others occur by direct extension or by the hematogenous or lymphatic routes. A rest abscess was mentioned by Ochsner as one following a general peritonitis in which all the pus is removed except that which remains in the subphrenic space.

Gas is often present in these abscesses and may be from a perforation or, according to some observers, from gas producing organisms. Beyer pointed out clearly that a serous pleural effusion often occurs early in subphrenic abscess and may proceed to an empyema. He also stated that the supraphrenic reaction frequently subsides spontaneously after subdiaphragmatic drainage. Thoracic complications occurred in 23, or 75 per cent, of his 31 cases of intraperitoneal subphrenic infections, while on the other hand, in 337 cases of empyema only 1 traversed the diaphragm to produce a subphrenic abscess and that one was due to injury of the diaphragm during drainage of an empyema. His findings would also indicate that a subphrenic infection produced by the streptococcus in combination with *Bacillus coli* or *Bacillus proteus* is especially likely to traverse the diaphragm. Thoracic complications were present in 3, or 50 per cent, of the cases in the present series.

¹From the Surgical Service of Dr. A. H. Montgomery at the Children's Memorial and the Presbyterian Hospitals. Presented before the Chicago Surgical Society February 2, 1934.

The symptoms often appear to be a continuation or exaggeration of the primary disease. Brown stated that in his cases that followed operations, the earliest time from the primary operation till the drainage of the abscess was 3 weeks and the longest was 21 months. In the present series of 6 cases there were 3 in which an operation preceded the abscess formation. The time between the operation and the formation of the abscess was 53, 36 and 156 days, respectively, with an average of 105 days.

One half of Gatewood's cases had hiccough. This was not present in any of the series reported here. Cough, dyspnoea, and pain and tenderness in the subphrenic region are usually present. Oedema of the lower axilla was present in 4 of Schwartz's 8 cases.

The physical signs usually described include dullness to flatness, diminished breath and voice sounds and vocal fremitus, with the presence of rales over the base of the lung. The dull area is convex upward and does not change its location with a change in position of the patient. If gas is present in the abscess cavity three zones of different resonance on percussion are present: normal above, tympany caused by the gas below this, and below the tympany is an area of flatness or dullness which on the left side is caused by pus and on the right side is caused by pus and the liver. If fluid is present in the pleura a fourth zone, one of flatness, is present which is between the pulmonary resonance above and the tympanic zone caused by the gas beneath the diaphragm. This fourth zone was mentioned as being present in 1 of the 4 cases in this report in which the abscess was on the right side. Signs of shifting of fluid were found in Cases 2 and 3.

Tuft stated that the heart may be pushed upward but judging from the literature this is rarely the case and it was not pushed upward in any cases of this report. He also reported that the heart is seldom pushed laterally. It was pushed laterally in 2 cases of this series. Elkin pointed out that there may be bulging in the epigastrium if the pus travels along the falciform ligament. This sign was present in 2 cases and bulging of the intercostal spaces in 1 case of this series. In 3 cases prominent veins were present over the abdomen.

The temperature in all cases was of the remittent type, as it was in the cases reported by Janz. At its highest point it averaged 104.3 degrees F. rectally. The leucocyte count ranged from 11,150 to 28,100 with a preponderance of the polymorphonuclear forms. The pulse rate varied proportionately with the temperature change.

The roentgenographic evidence is important but is often very difficult to interpret. Hoover stated that with a subdiaphragmatic abscess the costal border had a greater lateral excursion on the affected than on the sound side. The diaphragm is smoothly elevated on the affected side according to Gatewood. Hodges pointed out that the diaphragm is usually less elevated in the intra-peritoneal cases. According to LeWald in certain persons the left side of the diaphragm may be as high as the right, or in cases of eventration the left side of the diaphragm may reach even a higher point than the right side. Some believe that elevation of the posterior part of the diaphragm in lateral roentgenograms is of much importance. The diaphragm was elevated in all the cases reported herein.

Stress has been placed on the immobility of the diaphragm in subphrenic abscess. Hodges stated that a distant infection such as appendicitis may often cause an immobile diaphragm similar to that seen in a subphrenic abscess. In 3 cases of this series a decreased mobility of the diaphragm was noted on the affected side. Gas below the diaphragm was demonstrated roentgenographically in 3 cases.

There are few diseases which cause more uncertainty in the diagnosis. Brown was able to make a correct pre-operative diagnosis in only 7 of his 18 cases. In all the cases of this series a definite diagnosis of subphrenic abscess was made before operation. If the presence of a subphrenic abscess is kept in mind especially in patients with an infection such as appendicitis which does not clear up in the usual time, the diagnosis will be made more readily.

Gas just beneath the diaphragm is of some importance. However, Podkaminsky reported a confusing case in which the colon was between the liver and the diaphragm giving the appearance of free gas under the diaphragm. Therefore although the presence of gas between the liver and diaphragm is not absolutely pathognomonic it is very suggestive.

A roentgenogram taken in a lateral position will often demonstrate whether the fluid is above or below the diaphragm as shown in Case 3. A roentgenogram taken in the Trendelenburg position may show the lower limit of the cavity since the gas may be movable and in this position pass to the caudal limit of the cavity. LeWald advocated the injection of air into the abdominal cavity as a diagnostic procedure but it is questionable whether this would be entirely safe in all patients. Stewart suggested that as an aid in left-sided inflammations, air be injected into the

stomach or a barium meal given. A stomach tube was passed in Case 5 and it demonstrated clearly that the gas, which was present in the abdomen, was not in the stomach. In Case 6, a sinus remained following operation which did not heal, so opaque material was injected into it to determine whether the sinus led into the subphrenic space but the procedure was unsuccessful.

At the time of operation even after all the available diagnostic means have been employed the pus is often difficult to find. Many needle punctures may be necessary to locate the pus.

In the diagnosis other inflammatory diseases of the upper abdomen and the lower chest must be excluded. Touroff mentioned the diagnostic difficulties encountered in an encapsulated collection of pus between the lower surface of the lung and the diaphragm. Rácz stated that liver abscesses have ruptured through the diaphragm causing a hepatobronchial fistula without formation of a subphrenic abscess. In Case 6 the diagnosis was still uncertain even after operation. There was definite pus above the diaphragm but there was some question in the minds of some of those who examined the patient as to whether there was pus beneath the diaphragm. Beye mentioned that sometimes the opening through the diaphragm has been found only by palpation through an empyema drainage opening. Viethen thought it quite important to differentiate an abscess of the retroperitoneal space since the operative procedures in the treatment of the two affections may be quite different. He pointed out that in retroperitoneal space infections there are fewer lung symptoms the diaphragm is not pushed up it moves on the affected side and there is no pleural involvement. Yater and Otell successfully employed thorium dioxide sol intravenously with hepatosplenography in excluding 2 cases of suspected subphrenic abscess. Klein pointed out the uncertainty in differentiating an osteomyelitis of the spine.

The death rate in subphrenic abscess is higher than it should be. Brown's mortality in 18 cases which were operated on was 44.4 per cent. Gatewood's, in 38 cases (all adults except 1) was 29 per cent. Hodges, in 9 cases, was 40 per cent and Ochener's and Graves was 33.6 per cent in 1743 cases collected from the literature and including 50 of their own. Of the 6 cases here reported 1 (16.6 per cent) died.

Beye found that in 23 cases with thoracic complications his mortality was 43.5 per cent but in 8 cases without thoracic complications it was 25 per cent. Elkin stated that practically all patients who are not operated on die.

One of Schwartz's patients died 20 months after having had pneumonia and subphrenic abscess. In Case 6 almost 1 year passed from the time of the primary infection until the subphrenic abscess was diagnosed and operated on.

The treatment, of course, is surgical. Drainage may be made through the anterior or posterior approach. If the posterior approach through the pleura is attempted and the costal and diaphragmatic pleural layers are not adherent, the primary operation should be a subperiosteal removal of a section of one or more ribs and packing of this wound for a few days to obtain adhesions between the two pleural layers. A few days later by a secondary operation an attempt is made to locate and drain the abscess cavity. In case the two layers of the pleura are already adherent, the operation may be completed in one sitting. In some cases it may be impossible to decide before operation whether the two pleural layers are adherent in which case, the two stage operation must be used if the transpleural route is chosen. Brown thought it best to drain below the diaphragm (i.e. subpleurally) if the infection is retroperitoneal as in a perinephritic abscess. Ochener and Nather were firm believers in the posterior retroperitoneal approach for those in the right superior posterior space. In 19 cases so treated their mortality was 5.2 per cent. The abscess may cause a definite pointed bulging which is visible externally. In that case, it is best to drain at the place where bulging occurs whether this be anteriorly or posteriorly. The drainage tube should be left in place longer than in abscesses elsewhere because a subphrenic abscess has a tendency to recur. In Cases 3 and 4 the tubes were left in 39 and 14 days, respectively and the abscesses recurred. It was concluded that the tubes were removed too soon.

In this series 3 cases were drained through the anterior abdominal wall and 3 posteriorly by the transpleural route.

CASE 1. J. P. female aged 12 years, was admitted to the Children's Memorial Hospital December 28, 1932, presenting a history of vomiting, fever and pain in the right lower quadrant of the abdomen persisting for a period of 3 days.

Examination showed the throat was red but there was no upper respiratory infection. There was tenderness and rigidity of the muscles of the right lower quadrant of the abdomen and a probable intraperitoneal mass on the right side. Her temperature was 102 degrees F rectally, pulse 100 and respiration 24. The blood examination showed 5,050,000 erythrocytes, hemoglobin 86 per cent, and 26,000 leucocytes with 86 per cent polymorphonuclear forms. The urine examination showed nothing abnormal, the vaginal smear was negative for gonococci and her blood Wassermann was negative.

On the day of admission a diagnosis of acute appendicitis was made and the patient was operated on under ethylene anesthesia. Pus was encountered at the operation and the appendix was not removed, but a drain was inserted into the peritoneal cavity. Cultures of the pus showed *Bacillus coli*.

Following the operation the patient continued to be quite ill and after 6 days a fecal discharge appeared through the operative wound. On January 5 (8 days after admission) there was suppression of breath sounds and rales over the base of the right lung. In the abdomen a tender mass was present which extended from the right costal margin downward the breadth of two fingers. Six days later a roentgenogram showed increased shadows in the right hilum, thickening of the right costal pleura, and elevation of the right half of the diaphragm with compensatory lowering of the left half. On January 12 there was some bulging in the right upper anterior abdomen and in the region of the right eighth, ninth, and tenth ribs posteriorly. On January 18 a roentgenogram showed the heart farther to the left than normal.

Because of secondary anemia on January 19 she was given 300 cubic centimeters of citrated blood intravenously.

A tentative diagnosis of subphrenic abscess was made and on January 24 (days after admission) under nitrous oxide anesthesia, after a partial colectomy of the eleventh and twelfth ribs, needle was inserted a distance of 3 inches through the diaphragm. One hundred and forty cubic centimeters of pus was obtained, having a fecal odor and which on subsequent culture revealed *Bacillus coli*. Because of the danger of infecting the pleural cavity the needle was left in situ and connected with a bottle of water making a closed drainage. The wound was packed with iodoform gauze and left undisturbed for 4 days. The wound was then reopened under nitrous oxide anesthesia and a forceps was passed alongside the needle into the abscess cavity. About 350 cubic centimeters of pus was obtained and a large drainage tube was inserted. Nine days later the patient became afebrile but the wound continued to drain until April 15 (68 days after admission). On May 3 an appendectomy was performed and she was discharged as cured May 20.

CASE 3. M. C. female, aged 3 years, was admitted April 3, 1933, with a history of pain in the abdomen of 4 days duration, and convulsions, fever and green stools for 3 days.

Her birth had been normal and the previous history was not noteworthy.

On admission there was a redness of the throat and a nasal discharge. The spleen was palpable. The lower abdomen was tender and the abdominal muscles were rigid throughout but more so on the right side. She had a fever of 101 degrees F rectally and a pulse rate of 20. The blood examination showed 70 per cent hemoglobin and 17,500 leucocytes with 85 per cent polymorphonuclear forms. The urine showed nothing abnormal. vaginal smear was negative for gonococci and the Maslow test was negative.

A diagnosis was made of nasopharyngitis and peritonitis probably due to the pneumococcus organism.

On the day of her admission an epidemic of measles broke out in the hospital and as no convalescent measles serum could be obtained 30 cubic centimeters of coalescent erysipelas serum was given into the quadriceps muscle, as a general prophylactic measure.

Two days later the patient vomited and her abdomen became distended. Some prominent veins were noticed beneath the skin of the abdomen and they were more marked on the right side. The abdominal muscles were rigid throughout but more so on the left. Her temperature

was 105.4 degrees F. Three days later a diarrhea developed which lasted 3 days.

On May 3 a roentgenogram showed the diaphragm to be at the same level on both sides and also showed a shift of density in the abdomen suggesting free peritoneal fluid but no gas. For the following 3 weeks the patient continued to be quite ill with a constant fever, increased pulse rate, and tenderness of the abdomen.

On May 16 (33 days after admission) a red bulging area was noticed in the upper abdomen. This area was aspirated and found to contain blood and gas. At this time a diagnosis of subphrenic abscess was made. Two days later crepitation was found just above the needle puncture.

On May 20 the patient was operated on through a midline incision in the upper abdomen and gas and 300 cubic centimeters of pus escaped. Culture of the pus showed *Staphylococcus aureus* and *Streptococcus mitis* (Holman classification). Two days later the patient vomited and a foul brown discharge came from the wound. The discharge continued to have a foul odor and after 6 days it was found to contain bile. In the meantime the patient developed meningitis from which she recovered without any complications (she had previously received prophylactic coalescent erysipelas serum as noted above). On May 30 vomiting set in. It was bloody at times and continued until death occurred 35 days after her admission.

A necropsy showed a chronic perforated gastric ulcer on the anterior wall of the greater curvature of the stomach, a left subphrenic abscess, a generalized peritonitis, multiple abscesses of the lower left lung, bronchopneumonia of the lower right lung, and numerous partial adhesive obstructions of the small bowel. A culture of the pus obtained at necropsy showed *Bacillus coli*, *Streptococcus viridans*, and an organism morphologically resembling *Bacillus dysenteriae* but which on subculture was overgrown by other organisms and could not be further identified.

CASE 3. C. H. male aged 14 months, was admitted January 30, 1933, with a temperature of 103.4 degrees F rectally and for 3 days had had diarrhea, and restlessness.

Examination showed the right ear drum to be red and a consolidation of the lower lobe of the right lung which was diagnosed as lobar pneumonia. On January 27 tenderness was noted in the right upper abdomen and a percussion splash could be demonstrated. A roentgenogram showed gas beneath the diaphragm. On the following day it was noticed that the superficial vessels of the abdominal wall were dilated. The abdomen was distended, bulged in the right flank, and a shifting tympany was present as the position of this child was changed. At this time the blood examination showed 3,000,000 erythrocytes, 53 per cent hemoglobin, and 25,000 leucocytes. The urine showed nothing abnormal.

A diagnosis of subphrenic abscess was made and on February 1 (11 days after admission) the child was operated on under nitrous oxide anesthesia through a right upper anterior abdominal incision. Some gas and about 400 cubic centimeters of pus were found between the liver and the diaphragm. Cultures of the pus showed *Bacillus coli*. A rubber drainage tube was inserted.

Following this the patient was quite ill and on March 4 40 cubic centimeters of blood from the mother was injected into the buttock. Improvement occurred gradually and the drainage tube was removed March 1 (30 days after operation). He was afebrile after this and was discharged as cured March 2.

However he was readmitted June 30 after he had been ill for a week with a fever loss of appetite, and tenderness of the right upper abdomen. A diagnosis of recurrent subphrenic abscess was made. He was under observation for 5 days when the abscess ruptured spontaneously through

the old scar. The patient became afebrile July 20 and the discharge had ceased on July 30 (30 days after the second admission).

CASE 4. H. W. female, aged 10 years, was admitted August 28, 1931, complaining of pain in the right upper quadrant of the abdomen of 3 weeks duration. Anorexia and restlessness had been present for the past 2 weeks.

Eight months before she had had an appendectomy performed elsewhere and 2 weeks later an incision was made in the right lower posterior chest wall to evacuate some pus. This discharge lasted only 2 weeks. From the history and position of the scar it was thought that the child had had a subphrenic abscess.

On admission to the hospital, an examination of the right side of the chest showed the respiratory excursions diminished and marked tenderness on deep pressure on the lower portion with increased fremitus and dullness in this region. There was a healed scar over the right lower posterior chest in the region of the ninth interspace and another at McBurney's point. Her temperature was 101.6 degrees F, rectally, pulse 110, and respiration 22. Blood examination revealed 74 per cent haemoglobin and 21,150 leucocytes with 74 per cent polymorphonuclear forms. The urine showed nothing abnormal.

Röntgenograms revealed a marked elevation of the right half of the diaphragm and a diagnosis of recurrent subphrenic abscess was made.

Four days after admission the scar in the right lower chest became tender and red and, under ether anaesthesia, an incision was made into this old scar. Pus was found extending from just beneath the skin to the region between the liver and the diaphragm and a rubber tube was inserted. Cultures of the pus showed *Streptococcus hemolyticus*. Eight days after operation the patient became afebrile and on September 22 (25 days after admission) the wound closed and the patient was discharged.

CASE 5. C. D. male, aged 11 years, was admitted to the Presbyterian Hospital August 3, 1931, with vomiting and abdominal pain of 2 days duration. The pain in the abdomen began in the region of the umbilicus and later became generalized.

Examination showed the abdominal muscles to be tender and rigid throughout, but more so in the right lower quadrant.

The blood examination showed 4,950,000 erythrocytes, 88 per cent haemoglobin, and 33,600 leucocytes. The urine examination showed nothing abnormal.

A diagnosis of acute appendicitis and generalized peritonitis was made and, under ethylene anaesthesia, the patient was operated on through a right rectus incision. Much pus was encountered so the appendix was not removed, but three drainage tubes were inserted into the peritoneal cavity. The patient remained quite ill and on August 8 a pus pocket was opened through the old appendiceal wound. Later signs of a pelvic abscess developed and on September 16 the rectal wall was incised and through and through drainage was instituted from the old appendiceal wound and the rectum. A septic temperature developed and on August 29 (26 days after admission) roentgenograms showed elevation of both leaves of the diaphragm. Two days later the right subphrenic space was explored posteriorly in the ninth intercostal space, but no pus was found. On September 9 an incision was made in the epigastric region and gas and pus were found. Culture of the pus revealed *Bacillus coli* and an anaerobic coccus. Following this the patient improved and was afebrile after November 17. He was discharged December 12 (132 days after admission) with a healed wound.

CASE 6. C. B. female, aged 9 years, entered February 3, 1933, with pain in the right side of the abdomen, cough



Fig. 1. Case 6. Showing right diaphragm elevated with gas beneath but absence of gas elsewhere in right upper abdomen. Denseness of lower right lung.

vomiting, fever, dyspnoea and swelling of the left foot.

Her previous history was negative except for an attack of pneumonia at 7 years of age.

The patient's present illness dated back 1 year when she was treated at home for a few days with the diagnosis of acute bacterial endocarditis. She did not improve at home and entered the Cook County Hospital February 22, 1932, when a diagnosis was made of probable perforative appendicitis. Although she remained there 2 months no definite diagnosis was made nor an operation performed. From this date she was ill at home most of the time until January 31, 1933, when she suddenly developed paralysis of her right hand and a twitching of her mouth both of which lasted for 5 minutes. Four days later she entered the Children's Memorial Hospital.

Examination showed her to be dyspnoeic, cyanotic, and acutely ill. The left heart border was 2 centimeters beyond the left nipple line. There was a soft systolic murmur over the mitral area and a snapping second sound over the tricuspid area. The diameter of the right chest was greater than the left and the intercostal spaces on this side bulged somewhat. Litten's sign was negative on the right but positive on the left. The lower lobe of the right lung was dull on percussion and showed an area of cracked pot resonance with bronchial breathing and bronchophony. The liver edge was palpable at the level of the umbilicus. There was marked clubbing of the fingers and toes.

Her temperature was 105.4 degrees F, pulse 102 and respiration 32. Blood examination revealed 3,350,000 erythrocytes, 60 per cent haemoglobin, and 14,000 leucocytes. The urine showed ++ albumin.

TABLE I—SUMMARY OF CASES

Case	Age Sex	Primary disease	Organism	Length of illness	Time from primary disease to diagnosis of subphrenic abscess	Operative procedure	Time in hospital till afebrile	Time in hospital	Result
(U P)	7 ^{yr} F	Appendicitis	Bacillus	26,000	30 days	Drained posteriorly through the pleura	108 days	45 days	Recovered
(M C)	7 ^{yr} F	Chronic gastric ulcer	Staphylococcus aureus and Streptococcus faecalis (Bismuth stain negative)	1,400	39 days	Drained through anterior abdomen	Died 13rd day	55 days	Died
(C H)	14 mo M	Lobar pneumonia	Bacillus coli	21,000	30 days	Drained through right anterior abdomen	1st attack 55 days and attack 30 days	1st attack 64 days and attack 55 days	Recovered
(H W)	7 ^{yr} F	Appendicitis	Streptococcus hemolyticus	1,300	112 days from onset and abscess	Drained posteriorly through the pleura	6 days	4 days	Recovered
(C D)	7 ^{yr} M	Acute appendicitis	Bacillus coli aerogenes and an aerobic gram positive coccus	2,600	60 days	Drained through anterior abdomen	30 1/2 days	27 days	Recovered
(C A)	6 1/2 yr F	Acute appendicitis	Streptococcus hemolyticus in (Hidma classification)	24,000	245 days	Drained posteriorly through the pleura	5 days	104 days	Recovered

Röntgenograms showed a clouding of the lower half of the right lung and elevation of the diaphragm with a collection of gas and a fluid level beneath it (Fig. 2). Dr. Anasch, the roentgenologist, interpreted the findings as those of a subphrenic abscess, but others thought they indicated a bronchiectasis or a lung abscess.

From the physical findings of the heart a diagnosis of cardiac was made. The patient was so dyspneic that she was placed into an oxygen tent. On February 5 she coughed up 2 ounces of foul pus and 3 days later the chest was aspirated and 5 cubic centimeters of pus and gas were removed. It was thought that an empyema had ruptured into bronchus.

On February 1, under local anesthesia, a costectomy of inch of the eighth right rib was performed and the pleura was opened in the seventh intercostal space. Two ounces of pus were aspirated which on culture showed non-hemolytic streptococcus in (Holman classification). The region was packed with iodoform gauze. Four days later a cavity in what was thought to be the lung was opened by cautery and a drainage tube placed into the cavity. February 1 (10 days after admission) she had an attack of blindness which lasted 3 minutes. For the next few days she improved by the employment of postural oral drainage.

The discharge from the thoracotomy wound did not cease, so on March 30 an attempt was made to inject lipiodol into the sinus to determine its extent, but the attempt met with very little success. She was afebrile after 8 weeks. After a period of 5 1/2 months she had practically recovered and was sent to a convalescent home.

Even after this patient had recovered there was still a question of the complete diagnosis in the minds of some who saw her. The elevated right half of the diaphragm with a dome of gas beneath it and a fluid level beneath the gas supported the diagnosis of subphrenic abscess to such an extent that the case was included in this group.

It was believed that the patient had a subphrenic abscess which ruptured through the diaphragm forming a lung abscess which in turn ruptured into a bronchus.

Table I is a summary of the cases.

SUMMARY

1. Subphrenic abscess in children is not common. Six cases in children are reported in detail.
2. Four followed acute appendicitis, 1 followed a ruptured chronic gastric ulcer and 1 followed lobar pneumonia.
3. Three were operated on by the anterior and 3 by the posterior approach.
4. One (16 2/3 per cent) of the 6 patients died.
5. Judging from these cases, the clinical course of subphrenic abscess in children differs very little from that of adults.

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URTERO-INTESTINAL ANASTOMOSES

THE USE OF MECHANICAL ANASTOMOSING APPARATUS

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THE majority of clinical and experimental evidence in uretero-intestinal anastomoses has shown that the reconstruction of the natural valve as devised by Coffey (3) is essential for a good result. The formation of this mucous membrane valve apparently prevents the regurgitation of the contents of the bowel into the transplanted ureter. Although the majority of surgeons provide for the formation of the Coffey valve, their method of introducing the ureter into the lumen of the intestine varies. Coffey has recommended the use of ureteral catheters tied into the ureters at the time of transplantation and brought out the rectum for drainage (4). This method prevents the occlusion of the ureter by swelling and allows bilateral transplantation at the same time. Mayo introduces the ureter into the lumen of the intestine without the use of ureteral catheters followed by transplantation of the opposite ureter at a later date. Although good clinical results have been reported the construction of the Coffey valve has not entirely settled the difficulties resulting from ascending renal infection. Patients frequently give evidence of ascending renal infection while the ureteral catheters are tied in place. This would more or less rule out the lumen of the ureter as the conveyor of the ascending infection to the kidney. The problem of ascending infection to

the kidney therefore, continues to be one of the fundamental problems in the operation of transplanting the ureters into the intestine.

Sweet and Stewart, working on the problem of ascending infection of the kidney, concluded that an extensive network of lymph vessels and channels exists in the mucosa, submucosa, in the external coats of the bladder and ureters, and in the entire structure of the kidney. Also that the lymphatic network of the ureter anastomoses freely with the lymphatics of the bladder and kidney. They concluded from their experimental work that the ascending infection travels through this lymphatic system and not through the blood vessels of the ureter or through the lumen of the ureter. Sisk, Wear and O'Brien, in 1931 reported that transplantation of the ureters to the sigmoid in dogs was a highly unsatisfactory procedure by the Mayo technique. The completed tube technique of Coffey gave only slightly better results. They had two animals in which one side was transplanted with the tube technique of Coffey. The kidneys were in good condition but the dogs never appeared well after the operation. They obtained an infected kidney in two dogs by transplanting a ligated ureter. This apparently ruled out the lumen of the ureter as a route of ascending infection. They obtained better results in their experiments by protecting



Fig. 1. A badly damaged left kidney following a left ureteral transplantation 133 days previously by the transfixing suture method of Coffey. The right kidney weighed 40 grams, the left kidney weighed 16 grams. There was a good opening into the sigmoid.



Fig. 2. Pyelogram of the kidneys shown in Figure 1. The left kidney pelvis is slightly dilated and the lower pole of the kidney entirely destroyed.

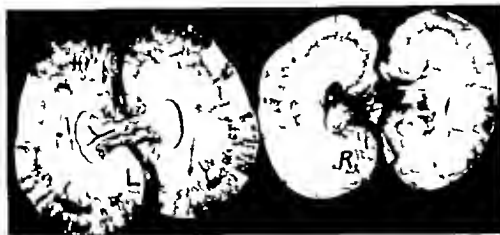


Fig. 3. Cross section of kidneys 75 days after left ureteral transplantation by the transfixing suture method of Coffey. The left kidney was filled with multiple abscesses.

the end of the ureter for a time from infected material. They believed that the solution of the problem of ascending renal infection probably depended upon the discovery of means to prevent infection through the lymphatics.

Coffey (5) recently advocated a method of transplantation which attempts to protect the end of the ureter. A ligated ureter is buried in a manner to effect a valve but a direct opening into the intestine is not made. A silk suture is so placed through one half of the ureter and through the intestinal mucosa that when tied tightly it will slough through leaving an ureterorectal fistula. This does not protect the lymphatics entirely as the suture is infected as it is passed through into the lumen of the intestine. In addition this method does produce a period of obstruction which is not desirable, especially in kidneys which are usually already infected. We have tried this method in a few dogs with varying degrees of success (Figs. 1 to 4). More recently Higgins has described a method of using the transfixing silk suture to effect the uretero-intestinal anastomosis at the same time preventing urinary obstruction. The ureter for a short distance is lifted from its bed and its continuity to the bladder maintained. The mobilized portion of ureter is transplanted into the wall of the sigmoid and a silk mattress suture placed to include the wall of the ureter into the lumen and then through the mucosa of the intestine. This suture is tied quite tightly and will slough out in a short time leaving the uretero-intestinal fistula. At a later operation the ureter is divided and ligated as it leaves the wall of the intestine. The end is covered in the wall of the sigmoid and the vesical end allowed to remain or be removed with the bladder in cases of bilateral transplan-

tation. This method should be an improvement on the transfixing suture method as described by Coffey. However the silk suture is contaminated and the lymphatics are immediately exposed to infection. In addition a second operation would be necessary to complete the anastomosis. The author states that he has used the method with most satisfactory results in 7 patients. No definite experimental results are given.

Experimentally better results have been obtained by making an effort to protect temporarily the end of the ureter from infection as the



Fig. 4. Bilateral transplantation by the transfixing suture method of Coffey. An excellent kidney was obtained on the right side which had been transplanted for 145 days. A large hydronephrotic kidney was found on the left side which had been transplanted 85 days. There was no communication with the sigmoid.



Fig. 5 Drawing showing the Boari buttons. A direct implantation into the intestine was made.

lymphatics apparently play a definite part in the ascending infection to the kidney. The end of the ureter therefore should be protected from infection for a sufficient period to allow for occlusion of the lymphatics and at the same time permit the escape of urine. This can be accomplished by a mechanical device which allows an aseptic transplantation of the ureter and at the same time permits the escape of urine. By such a method the preparation of the patient would be greatly simplified, the dangers of contamination at the time of operation avoided, and the open lymphatics protected from immediate exposure to infection.

A mechanical device for the transplantation of ureters was introduced in 1895 by Boari, an Italian surgeon (Fig. 5). The buttons were made in various sizes. The drawings show the principle on which it worked. The button would slough out in a few days and pass by rectum. When the ureter was implanted into the bladder of males it was necessary to remove the button by cystotomy. He reported a good result following the transplantation of the left ureter into the descending colon in a case of vesicovaginal fistula. Cowart in 1895 used the Boari button to transplant the left ureter in an advanced case of vesical tuberculosis. The patient lived for 35 days. Turetta in 1899, did a bilateral uretero-rectal anastomosis with the use of Boari buttons but the patient died on the sixteenth day after operation. Of course in these cases the ureter



Fig. 6 Drawing showing the hollow nickel tube described and used by Chabot.

was directly implanted into the intestine and no effort made to cause the reproduction of a natural valve.

Another mechanical device was designed and successfully used by Chabot in 1896. He designed a hollow nickel tube with cone-shaped ends (Fig. 6). The tube was 3.5 centimeters in length and its inside diameter measured from 2 to 3 millimeters. One and one-half centimeters from one end there was a groove large enough to receive a loop of thread, which was tied around the end of the ureter after it had been slipped over the smaller end of the tube. The rectal end of the tube was perforated to allow attachment of a thread by which the cylinder could be withdrawn later. The patient was living a year after bilateral uretero-rectal anastomosis had been performed.

Poth has recently proved experimentally the value of using a small metal cannula for performing cystoduodenostomy. He states that it has been successfully applied to the transplantation of pancreatic ducts and ureters, giving a rapid technique for anastomosing small ducts into larger hollow viscera.

Several types of mechanical appliances were tried before a method was devised which allowed a sterile transplantation of the ureter into the rectum and at the same time permitted the escape of urine. The methods were varied frequently but it was possible to transplant a ureter successfully by such a method. Although the instruments to be described and the results obtained can be greatly improved the method is reported in the hope that further work may be done, which will indicate advantages in the use of such a method in patients.



Fig. 7 Cross section showing the small draw snap in place and after sloughing into the rectum.



Fig. 8 Left side transplanted by the dress snap method 110 days previously. The left kidney weighed 48 grams. The right kidney weighed 45 grams.

EXPERIMENTS

All experiments were conducted on dogs. The animals were given a cathartic consisting of 30 cubic centimeters of castor oil on the day previous to operation. All food was withheld the day of operation and the rectum cleansed with several soap suds enemas. The animals were given a preliminary hypodermic of 0.015 grams (or 15 milligrams) of morphine previous to the induction of ether anesthesia. The abdomen was shaved and the skin cleansed with alcohol and bichloride of mercury solution. The abdomen was opened through a low midline incision in the female animals and a muscle splitting incision in the male animals. The left ureter was transplanted in the majority of our experiments.

An enlarged model of a dress snap was used in the first group of experiments (Fig. 7). The male portion of the button was about one-quarter of an inch in height. A hole was made in the base of the snap to allow a heavy thread to be tied through it. This part of the button was then inserted into the cleansed rectum with a long clamp to hold it in place. The thread was long enough to protrude from the rectum. The abdomen was opened under sterile conditions, and the ureter prepared for transplantation. The female portion of the button was then anchored by several fine catgut sutures to the end of the ureter. The wall of the sigmoid was prepared by making an incision through the muscularis down to the mucosa for a distance of about 1.5 inches. At this point the male portion of the snap in the lumen of the sigmoid could be easily palpated. An unsterile assistant loosened the clamp holding the button in the rectum allowing it to be brought up into position with the thumb and index finger of the left hand (Fig. 14). The

mucosa over the button was sponged dry and the female portion of the button fitted just close enough to allow for the extra thickness of the mucosa. The muscularis was then closed in two layers after the method of Coffey. From 3 to 7 days later the snap was either passed by rectum or could easily be pulled out by the silk suture protruding from the rectum (Fig. 7). A good kidney was obtained in 3 of the 5 dogs in which this method was used. In one of our failures a small dog was used and the end of the small ureter was severely traumatized at the time of operation. There was no opening into the sigmoid in this animal. The opening into the intestine was quite large in the three good results. The animals were allowed to survive 29 days, 58 days and 110 days (Figs. 8, 9, 10). Although good experimental results could probably be obtained in large dogs by this method it does



Fig. 9. Pyelogram of kidneys shown in Figure 8. The left kidney pelvis is slightly dilated.



Fig. 10. The left side transplanted by the dress snap method 30 days previously. Each kidney weighed 36 grams.

give a period of urinary obstruction which makes its use prohibitive in patients.

An attempt was made in the second group of experiments to insure an aseptic transplantation and at the same time permit the end of the ureter to protrude more into the lumen of the intestine. Small rectangular metal boxes were used varying in size from one half to one inch in length and about one quarter to three-eighths of an inch in width. The male part of the box was inserted into the rectum as in the first group of experiments. At one end of the female part of the box a small metal gooseneck projection was placed which would pass into the lumen of the ureter and allow the ureter to be anchored about its base. It was hoped that the end of the ureter would project for some distance into the sigmoid following the passage of the box which gave a rectangular opening in the mucosa beneath the end of the ureter. Although several good results (Figs. 11, 12) were obtained by this method, the majority were badly damaged kidneys or more frequently there was no communication with the lumen of the sigmoid. The box was too large and a slough of the muscularis covering it frequently occurred resulting in peritonitis. The opening through the mucosa was also entirely too big, thus making this method unsatisfactory.

It became obvious from the early experiments that the opening into the mucosa must be kept quite small. Furthermore, no provision had been made to permit the escape of urine. The final group of experiments were carried out with varied modifications of the button shown in Figure 13. The cross section of the button in place demonstrates how it permits the urine to reach the outside immediately after the button has been pressed together. The male portion of the snap

with attached catheter is inserted into the rectum and held in position by a long dressing forceps.

After the abdomen has been opened and the mucosa prepared the button is grasped by the thumb and forefinger (Fig. 14) and the clamp in the rectum is released by the unsterile assistant. The button in the cleansed rectum is always easily identified and brought into place. The unsterile assistant then injects water through the catheter projecting out the rectum to wash away any material which might occlude the opening of the pointed catheter in the snap. This also washes foreign material from the mucosa over the button which might prevent proper approximation of the two parts. The sterile portion of the button with a small catheter attached and sutures passed through the top of the button for anchorage of the ureter is then pressed into position. An attempt has been made to allow just room enough for the mucosa to be pinched tightly but not entirely cut at the time of transplantation. It must be admitted that as yet the buttons have not always been satisfactory in holding together. Another model should be constructed which would screw the parts together and absolutely prevent their separation at the time of operation as well as at the time of sloughing through into the rectum.

About 6 inches of the end of a No. 7 whistle tip catheter is usually used on the sterile portion of the button. After the parts have been pressed together sterile saline is injected into the catheter to make sure a free communication exists with the outside. The unsterile assistant collects the fluid to make sure of a return flow through the catheter in the rectum. The short catheter is then threaded into the ureter and the end of the ureter anchored to the button by several of the fine catgut sutures pre-



Fig. 11. The right ureter transplanted for 70 days using a small metal box. The right kidney weighed 55 grams. The left kidney weighed 60 grams.

viously placed through the button (Fig. 15). In later experiments the end of the ureter was split about one-quarter of an inch to prevent so much injury and resultant sloughing of the end of the ureter after it was sewed down to the button. In addition, the flat end of the divided ureter could be anchored to the mucosa just beyond the button (Fig. 16). This prevented it from slipping upward following the removal of the button. A viable ureter would also be present beyond the small opening where the button sloughed through the mucous membrane. The muscularis was closed in the usual fashion by the use of fine continuous catgut or interrupted silk sutures (Figs. 17, 18).

Immediately after operation the animals were given 500 to 1,000 cubic centimeters of normal saline intravenously. Usually this prompted a rapid flow of urine from the catheter protruding from the anus. The catheter was allowed to protrude from the anus about 1 to 2 inches. Occasionally the animals would bite the catheter and pull the buttons apart thus ruining the experiment. The administration of intravenous saline was continued for a week or more. It is probably more important to force fluids immediately after the button comes out than while in place because of the contact of the ureter at this time with intestinal contents and possible occlusion of the lumen of the ureter following removal of the short catheter. The catheter should be inspected rather frequently to insure a continuous flow of urine. The flow of urine can usually be started following suction with a large syringe and a needle inserted into the catheter extending from the anus. Several of our early experiments were complicated by injecting mercuriochrome or saline up the catheter to start the flow of urine and grossly contaminating the lumen of the

ureter. Immediately following this injection the animals developed a high temperature and usually died.

The drainage button was varied several times in an attempt to make the anastomosis easier and improve the results. Several good kidneys (Figs. 19, 20) were obtained in the first experiments in which a rather large button was used and a doughnut-shaped piece of mucosa cut out at the time of operation. This gave too liberal an opening into the mucosa and sloughed out within 2 days which was apparently too early for persistently good results. The technical part of uniting the button was made much easier by making the metal opening in the rectal part of the button quite large. The metal catheter in the sterile part of the button could then be easily pushed into place. Thus telescope drainage button apparently produced too large an opening into



Fig. 12. Pyelogram of kidneys shown in Figure 11. The right pelvis is slightly dilated.

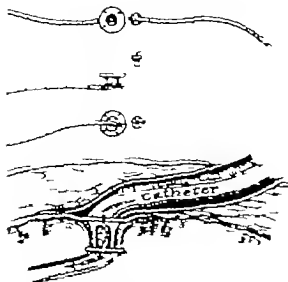


Fig. 9. Construction of the drainage button.

the mucosa and the results were poor. The best results were obtained by using a drainage button patterned after the first one used, only much smaller (Fig. 10). Sufficient space was allowed



Fig. 10. The part of the button placed in the rectum is brought up and held beneath the mucosa between the thumb and index finger. The sterile portion of the button and catheter is made to be pressed into position.

between the two parts of the button to permit the mucosa to be snugly compressed but not immediately cut. This made the button remain in place over a longer period of time. With days



Fig. 11

Fig. 11. The button in place with communication through catheter to the outside. The ureter is being drawn down to be sutured to the button.

Fig. 12. Drawing showing the split end of the ureter which is anchored to the button and as well to the mucosa beyond it. The latter suture does not, however, enter the lumen of the intestine.



Fig. 12



Fig. 13

Fig. 13. Closure of the muscularis over the ureter. It is not necessary for the wall of the ureter to be included in the suture when it is anchored behind the button.

Fig. 14. Drawing showing the second layer of suture which are made to approximate the muscularis over the ureter.



Fig. 14



Fig. 19. One of the early experiments in which the drainage button was used. The left ureter was transplanted 30 days previous to sacrifice of the animal. The left kidney weighed 60 grams. The right kidney weighed 70 grams. The phenol sulphophthalein function test gave an output of 20 per cent in 15 minutes on the right side compared to 18 per cent on the transplanted side.

however, it was difficult to keep the apparatus in place over 2 to 3 days, which is an insufficient period of time. It would be comparatively easy in patients resting in bed to keep the button in place a week or even longer. The dangers from pulling out the protruding catheter would be obliterated, the fluid intake better controlled and a closer check could be maintained to avoid obstruction to the system. The button would be made several times larger for use in patients, which would no doubt rule out a great part of the difficulty resulting from the occlusion of the small tubes which must necessarily be used in animals.

The small drainage button was used in 18 dogs. One animal died of distemper 19 days after operation, and the kidney on the transplanted side was in very good condition. A good result was obtained in 6 animals, or 35 per cent of the remaining 17 animals (Fig. 21). There was a large opening of the ureter into the sigmoid

in these cases. Five of the 11 failures could be definitely traced to correctable errors at the time of operation or immediately afterward. The end of the ureter was ruined in 2 animals by an attempt to pull the ureter down over too large a catheter.

Two failures were in experiments in which the suture line in the sigmoid was rotated and anchored to the side wall of the pelvis. Apparently this twisted the ureter and injured its blood supply as it was sealed off as it entered the wall of the sigmoid. The split end of the ureter was sewed to the small metal tube without the use of the catheter in 2 cases in which good results were obtained. A prognosis could usually be made after the first week following the operation.

A consistent elevation of rectal temperature above 39 degrees C generally indicated infection

No.	Ureter transplanted	Survival days	Weight of kidney		Phenolsulphophthalein per cent		Result
			Right	Left	Right	Left	
A	Left	136	44	46	15	15	good
B	Left	108	56	5		7	good
C	Left	156	5	46	15	7	good
D	Left	94	50	44	15	15	good
E	Left	90	41	41	not done		good
F	Left	90	47	41		7	good

Phenolsulphophthalein administered in 1 cubic centimeter dose. Urine collected for 15 minutes following appearance of dye.



Fig. 20. Pyelogram of the kidneys shown in Figure 19. The left ureter and pelvis are moderately dilated.



Fig. 1

of the kidney and a poor result could be expected. The animals lost some weight following the transplantation and usually carried a moderate elevation in temperature. A diarrhea was often found to be present.

SUMMARY

Previous experimental evidence indicates that better results can be obtained in uretero-intestinal anastomosis if the ureter is temporarily protected from contamination. Contamination of the open lymphatics of the ureter at the time of operation is probably a major route of ascending infection to the kidney.

A mechanical appliance is described which answers the experimental requirements for protection of the ureter and which permits the immediate aseptic drainage of urine.

A review is given of the previous mechanical appliances used in ureteral transplantation. The mechanical efficiency of the drainage button described can be greatly improved by changing

the design to such a degree as to allow the parts to screw together thus preventing their separation.

It is suggested that a much larger drainage button of such a design could be advantageously used in patients with good results.

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PECTENOSIS AND MINOR MALADIES OF THE ANAL REGION¹

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MINOR maladies of the anal region are a fruitful cause of discomfort and embarrassment to both patient and physician, as may be judged by the numbers who seek relief at the hands of the specialist and in the clinic and further by the diversity and multitude of procedures which have been advocated and employed for their relief. Apart from the patient's physical affliction, the psychological effect of the condition is often of such importance as to amount to a neurosis. It is this mental state associated with anorectal lesions, and the difficulty which the physician experiences in ameliorating what seems to the patient to be a comparatively trivial though none the less real, lesion, which often makes these patients difficult to handle and complicates the treatment.

The purpose of this paper is to draw attention to the importance of a variety of lesions found in the anal canal and to record some personal observations as to their clinical findings and treatment. Many of these lesions have a common etiological basis in what Miles has called "Pectenosis." Pectenosis does not seem to have received, in this country, the attention that it deserves.

It is necessary at this juncture to consider certain preliminaries in the nature of the anatomy and physiology of the lower end of the alimentary tract, preliminaries nowhere of more importance for a correct appreciation of the many and varied pathological lesions which occur in this region.

The current descriptions of the anatomy of the anal canal found in modern textbooks of anatomy and proctology are frequently incorrect. As often happens, pathological investigations lead to a closer examination of anatomical detail and bring to light points which traditional descriptions have neglected, or but cursorily mentioned. It is these points which are essential for what follows and for the correct interpretation of certain anorectal lesions.

For purposes of study and teaching we prefer to think of the anal canal as presenting four landmarks, namely: (1) the anocutaneous line, (2) the white line of Hilton, (3) the pectinate line, (4) the anorectal line (see illustration).

1. The anocutaneous line marks the lower end of the gastro-intestinal tract. Stratified squamous epithelium is found on both sides of this line. It is easily identified, however, because no hair follicles

and but few sweat glands are to be seen cephalad to this margin. The epithelium above this line is usually thrown into folds by the action of an involuntary muscle by some termed the corrugator cutis ani. This muscle represents the lower medial end of the longitudinal muscle of the bowel which also forms the sheath of the sphincter ani externus.

2. The white line of Hilton lies 1.5 centimeters above the anocutaneous line. Hilton in his classical description of this landmark in 1863 described this line as white; this is so in the cadaver but in the living subject the line is decidedly blue in color. This area, he believed, corresponded to the division between the hind-gut and proctoderm. In 1896 Stroud, a physiologist, was impressed by the fact that all of the surface area cephalad to the white line and limited by the pectinate line above, was lined by transitional epithelium. It is, therefore, neither skin nor mucosa. This area is somewhat irregular in breadth, varying from 6 to 9 millimeters. The surface is smooth and has a glossy shining appearance. Its general form may be likened to that of a saw with irregular teeth pointing upward. The dentations interdigitate with those of the rectal columns of Morgagni to form the so called anal papillae. The appearance of this area, with its dentations, led Stroud to call this region the pecten, from its resemblance to a comb (*L. pecten*).

3. The pectinate line is represented by the lower margins of the sinuses and columns of Morgagni. This line marks the location of the anal valves and anal crypts, the latter opening into the recesses between the lower ends of the sinuses of Morgagni. This line is also called the valvular line and also the dentate margin. This landmark is readily identified and is important, for the majority of the lesions with which we deal occur in its vicinity.

4. The anorectal line is 1.5 centimeters above the pectinate line. Its exact position can be identified only with the aid of a microscope. Histologically that portion occupied by the rectal columns, the upper two-fifths of the anal canal, is lined by cuboidal epithelium and the rectum above by deep columnar epithelium. The transition is abrupt and it is this change which marks the division between anus and rectum. The anorectal junction, so formed, has one and one-half

inches above the anocutaneous line when the anal canal is empty.

In descriptions of this region the term mucocutaneous line or junction is frequently applied. This term, it is apparent from the foregoing should not be used, for it can be applied to designate several different levels of the canal and is therefore ambiguous. As we have seen the pectinate line indicates the lower end of the mucous membrane.

The pecten is a very important area. Here is a divide separating blood supply lymphatic drainage and innervation. It is, indeed, a physiologic threshold. The middle hemorrhoidal vessels fail to send adequate blood supply to the part and it therefore depends upon the anastomoses from above and below for its arterial supply and venous drainage.

When the anal orifice is closed the pecten forms the central part of the floor of the rectal ampulla. It is reasonable to suppose that it should be the seat of special sense organs whose function is to regulate the action of the sphincter muscles. The nerve mechanism is extremely complex. It may be explained by dividing the muscles into two groups, voluntary and involuntary, the action of these two groups being complementary and antagonistic. The voluntary muscles are the sphincter ani externus and the levatores ani. The involuntary muscles are the sphincter ani internus, the corrugator cutis ani, and the important longitudinal muscle of the bowel. The voluntary muscles act through the cerebrospinal nerves with impulses initiated in the cortex. The involuntary muscles are under the control of the sympathetic and parasympathetic systems. There is here an overlapping of a series of complex reflexes, interference with any one of which will bring about an upset in the nicety of balance and increase any pathological process occurring in this region.

The voluntary mechanism of the lower intestinal tract has by far the major rôle in the initiation of the act of defecation. Normally the rectum is empty, and it is not until the ampulla receives a portion of the fecal mass that the voluntary mechanism is called upon. Interference with the functional processes of the sympathetic and parasympathetic systems may cause either an inhibition or an overstimulation of peristalsis. This I believe explains why habits, diet, exercise and psychic influences almost entirely dominate the process of fecal excretion. There is however an intimate relationship between the voluntary and involuntary actions. As long as the normal balance between the several sphincters is maintained the physiologic functions are normal but if the reflex

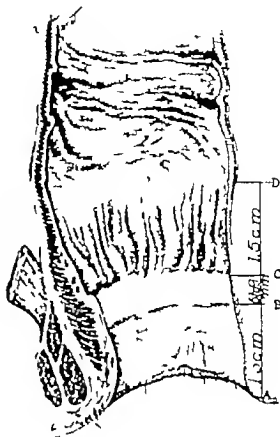


Fig. 1. Anatomical drawing of the anal canal showing the musculature and surface landmarks. A The anocutaneous line B the white line of Hilton C the pectinate line D the anorectal line B-C the pecten.

arc is disturbed by the failure of any component part the normal tone of the muscles is upset. The muscles either become atonic or they are thrown into a state of hypertonicity or spasm. Both of these conditions may be present at the same time. This may lead to passive congestion the principal etiologic factor in many anal maladies.

Chronic passive congestion, as elsewhere, leads to round cell infiltration, the laying down of fibrous tissue in the submucosa, cicatrization, and the production of a condition which is termed pectenosis. Pectenosis therefore, may be defined as a pathological condition in which a circular deposit of fibrous tissue occurs in the submucosa of the pecten—that area of the anal canal which we have previously defined as being bounded below by the white line of Hilton and above by the pectinate line. This condition was first described by Ernest Miles in a paper published in 1918 and since by Abel in 1932. The fibrous deposit takes the form of a ring which encircles the canal and was called by Miles the pecten band. It varies both in breadth and thickness according to its duration. It is usually about one-third of an inch broad and

TABLE 1—PECTENOTOMY IN ADDITION TO THE USUAL EXCISION ETC

Treatment	Cases
Anal fissure	26
Internal hemorrhoids	10
Pruritus ani	14
Anorectal fistula	4
External hemorrhoids	5
Tight orifice with rectal constipation	3
Total	63

one-sixth of an inch thick. It can be felt distinctly by compressing the anal margin between the finger in the anus and the thumb outside. In well marked examples it may be compared to a rubber umbrella ring surrounding the anus. Pectenosis is said to be analogous to the formation of fibrous tissue in the submucosa opposite the cricopharyngeus muscle in globus hystericus (McKenzie 1918 Abel, 1929). In 7 of our cases a wedge-shaped section of the band was removed and sent to the pathologist for histological examination. In 5 of these the slides demonstrated dense fibrous tissue. In 2 the pathologist reported striated muscle with fibrous tissue. These reports disarm any criticism that the band divided was the external sphincter and indicate the true nature of this deposit.

Pulsive congestion may result from a variety of causes e.g. varicose of the hemorrhoidal veins, contusions or lacerations from the passage of hard fecal masses, ingested foreign bodies, irritating liquid stools, etc. The resulting pectenosis may be compared to the fibrosis at the periphery of a varicose ulcer of the leg. Avascularity loss of elasticity rigidity of the anal wall and mechanical obstruction ensue all factors related to the development of anal fissure hemorrhoids, or abscess. Pectenosis, likewise, is often present in pruritus ani, sometimes precedes the development of rectal constipation and may be associated with spastic colon.

In the past year and one-half I have operated upon 83 patients whose lesions could be explained by the presence of pectenosis and a pecten band (Table 1). In some this was incidental, but in the majority it seemed to be the primary factor. Attention is drawn to the variety of conditions which are founded on a common basis.

In each case the band was completely incised. When this is done the free ends of the band retract, the orifice relaxes, and after several months, when improved circulation is established the fibrosis is absorbed. It is not necessary to excise the band.

The characteristic white fibrous tissue seen at the base of a fissure is always a part of the pecten

band. In the operation for fissure it is seldom necessary to incise any of the fibers of the external sphincter. It is, of course, possible to cut the external sphincter without dividing the band. Recurrence of fissure following operation is often due to the fact that the band has not been completely divided. One of our patients was a Chinese boy of 22 with a typical deep posterior fissure of several months duration. A definite pecten band was demonstrated and was divided through an incision to the left of the midline. An experiment the fissure as such was not dealt with. Following the pectenotomy the orifice was well relaxed and in 3 weeks the fissure was healed. We do not advocate simple division of the band in fissure, but combine excision with pectenotomy.

In operating upon anorectal conditions one often has difficulty with a narrow orifice, and most surgeons therefore practice division as a routine procedure. This is always dangerous. It produces multiple contusions and may result in the development of hematomata and abscesses, but the harm lies mainly in the tearing of the underlying tissue or even the bowel wall itself producing a further fibrosis and associated congestion and, as a consequence the creation of a vicious circle which still further devitalizes the part, to say nothing of the possible damage to the delicate nerve plexuses which as we have seen must play an important rôle in the maintenance of that balance which is so necessary for perfect function.

In this regard it is interesting to speculate as to the relationship of nerve development to anorectal lesions. Anal papillae peculiar to man, are said to be present in 40 per cent of people. They consist chiefly of nerve fibers and ganglion cells and are said to constitute accessory sense organs. These anal papillae have been present in the great majority of our cases of pectenosis.

Pruritus ani is a frequent symptom of pectenosis and some of these patients can be cured only by pectenotomy. Venous stasis results in an inadequate blood supply to the perianal skin. The skin is thickened and the hypertrophy sometimes takes the form of radial folds with deep recesses. The congestion of the mucous membrane above results in increased secretion of mucus which in turn bathes the skin with an irritating liquid. Scratching and rubbing of the part, together with the usual over treatment and improper hygiene, complete the necessary factors for a miserable existence.

From the foregoing pathological studies we can see that relief from pectenosis may be expected from simple section of the band. Many such patients have been cured by division but, as sug-

gested, the patient may be left with a condition far worse than he had originally.

The operation is usually performed with the patient in the left lateral Simms position or the lithotomy position. For our purposes the residual intrathecal anaesthesia of Hassler is preferred. Forty to 50 milligrams of procaine hydrochloride, dissolved in 1 cubic centimeter of spinal fluid is slowly injected into the second or third lumbar interspace. This is given with the patient in the sitting posture and he is made to sit up for at least 3 minutes thereafter. This gives a saddle anaesthesia of the perineum without affecting the outer thighs and legs, and there is seldom any change in blood pressure. These patients rarely have headaches and they are free from the post operative discomfort in the lower limbs which is so common in complete spinal anaesthesia. In those patients who need only a simple section of the band, local nerve block of the perineal branches of the fourth sacral nerves in the ano-coccygeal body has been found to be quite adequate. Occasionally the use of gas and oxygen is indicated.

The band may be incised in any part of its circumference but we prefer the posterior segment at a point just to the left of the midline (5 o'clock). A radial incision, parallel with the long axis of the bowel is made with a knife. It extends upward for about 2 centimeters from a point just below the anocutaneous line. This incision should end at the pectinate line so as to avoid the mucosa because of the danger of injuring the superior hemorrhoidal artery or its branches. The incision is superficial. The fibrous band is identified and a straight artery forceps is forced through the epithelium at the pectinate line. The blades of the forceps are separated and the band is completely incised. Immediately the orifice is relaxed and the mucosa is everted. Other lesions can then be dealt with. Bleeding points are ligated. No su-

tures are applied. A small wick of vaseline gauze is placed in the anus and a tight perineal pad is applied. This procedure differs from that of Miles who has his patient in the right Simms position and who inserts his finger into the anus, everts the anal margin with his thumb on the perianal skin and makes an incision over his finger. We find it easier to identify the band with the aid of blunt dissection.

The bowels are confined for 2 or 3 days with the aid of *mistura catechu* compound. Two sitz baths daily are ordered, beginning the day following the operation. The wound heals by granulation in from 10 days to 2 weeks.

SUMMARY

- 1 Many minor maladies of the anal region have a common etiological basis in pectenosis.
- 2 Pectenosis is a pathological condition resulting from passive congestion and results in a fibrous ring in the submucosa of the anal canal.
- 3 The practice of divulsion is always dangerous.
- 4 Pectenotomy is the method of choice and has alleviated a variety of lesions, founded on a common basis, pectenosis, as evidenced in an experience of 83 cases.

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EPITHELIOMA OF THE LOWER LIP

RESULTS OF TREATMENT

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THE relative value of different therapeutic agents employed in the treatment of a given condition can be determined only by observation and study of the results obtained over a considerable period of time. Often a new form of treatment is enthusiastically heralded as almost specific, whereas within a few years it is entirely discarded. Often, too, a given form of treatment will continue in popular use for a much longer time than its efficacy justifies. Of the different forms of treatment used for carcinoma of the lip excision, irradiation, electrocoagulation, and escharotics are most widely employed. Opinions concerning the effectiveness of these agents vary greatly and it was with the object of securing definite data regarding some of them that this study of the results of treatment was undertaken.

From January 1, 1920 to January 1, 1930 surgical measures, supplemented by treatments with radium and roentgen rays were used at The Mayo Clinic in cases of epithelioma of the lower lip. A review of the cases was undertaken in order to determine not only the end-results of treatment, but to ascertain the value of this supplementary treatment. Reports on the treatment of carcinoma of the lip from an entirely surgical standpoint, and other reports from a purely radiological standpoint, have appeared in the literature from time to time but comparison of the observations of different writers is more or less unsatisfactory especially in view of the fact that microscopic data commonly are entirely lacking in the group in which treatment is not surgical.

During the period under consideration, a total of 1,370 patients with epithelioma of the lower lip were examined in the clinic. In 337 of these cases no treatment was carried out because of the hopelessly advanced stage of the disease. In 31 of the cases treatment was entirely by means of radium and roentgen-rays, either because of the extent of the growth or the advanced age and poor general condition of the patient. In the 943 remaining cases treatment was either entirely surgical or was surgical supplemented by irradiation. These cases form the basis of the present study.

Carcinoma of the lower lip, because of its prominent situation, characteristic appearance, the fact that it early produces symptoms that lead the sufferer to seek relief promptly, and because of the ease with which the local lesion and the lymph nodes draining the region can be removed should not only be recognized early but treatment should with very few exceptions, result in complete cure. Many factors, however, tend to react against this almost ideal situation and lower the percentage of cases in which the disease is entirely eliminated. Some of these factors are the fault of the patient, others, no less important, must be charged against the medical profession. Among the former may be mentioned ignorance, indifference, procrastination, and self-treatment. The latter include lack of experience on the part of the physician, incomplete treatment, and improper treatment. It has been stated that the medical profession is responsible for more carcinomata of the lip reaching an inoperable stage than the public, and, while this is probably an exaggeration, it is not without some foundation.

INCIDENCE

The vast majority of epitheliomata of the lower lip occur among males. The incidence of the disease among females in groups of cases reported by different authors has ranged from 1 to 12 per cent. In this series of 943 cases, only 22 patients (2.3 per cent) were females, whereas 931 (97.7 per cent) were males. The disease belongs primarily to the degenerative period of life, as by far the majority of sufferers are past middle age. In this group 76.9 per cent of the patients were between 40 and 70 years of age, more than 65 per cent were past 50 years, and only 12.1 per cent were less than 40 years of age. The average age of the patients of the entire group was 54.3 years, of the males 54.4 years, and of the females 47.9 years. The distribution by age groups is shown in Table I. Since the termination of the period during which this group was observed, a boy aged 13 years, with a primary squamous cell epithelioma of the lower lip has been given treatment in the clinic.

All of the lesions included in this series were squamous cell epitheliomata which had originated

primarily on the vermillion border of the lower lip, the basal cell or the squamous cell epitheliomata that developed on the cutaneous surface of the lip and secondarily extended beyond the mucocutaneous margin were not considered nor were the lesions that originated inside the cheeks or on the jaws and later involved the lower lip, considered. The epitheliomata of the upper lip were likewise excluded. During the period of 10 years, 25 cases of primary squamous cell epithelioma of the upper lip were encountered, also 22 cases in which squamous cell epitheliomata originating on the cutaneous surface of the upper lip secondarily invaded the vermillion border.

In 50 cases (5.3 per cent) 2 or more distinct and separate epitheliomata of the lower lip were present at the time the patients came for treatment. Regardless of the plurality of lesions with which some patients were afflicted, each patient is considered to represent a single case. Moreover in each of 30 cases (3.1 per cent) an entirely new epithelioma developed on another portion of the lip of a patient who had been well for about 5 years following removal of the original growth. Each of these patients also is taken to represent a single case, but as the new lesions were definitely not recurrences they were not considered as such when the statistics were being compiled. Evidence of marked malignant tendencies in the tissues of some of these patients generally is shown by the fact that in 55 cases (5.8 per cent) malignant tumors other than those on the lower lip were present at the time of examination. These included lesions of the skin, the buccal cavity, tongue, stomach, intestine, and rectum. A number of the patients cured of carcinoma of the lip subsequently died because of an entirely unrelated malignant condition elsewhere in the body.

DURATION

The lesions of the lip dealt with in this series varied greatly in duration, appearance, activity, and extent. Some had been present only for a few weeks, others had existed for several years. The patient's statement must be accepted in this regard, and, as is well known, this is often unreliable even when pertaining to a lesion as conspicuous as an epithelioma of the lip. On this basis the average duration of the lesions to the time of examination of the patients in the clinic was 28.3 months. It was anticipated that the average duration of the growth on the lip would be found to vary inversely with the grade or activity of the lesion, but there was less regularity in this regard than was expected. The average duration of the lesions of grade 1 was 24.3 months, and lesions of

TABLE I—AGE INCIDENCE

Years	Patients	Per cent
15-19		0.10
20-29	80	1.18
30-39	100	1.61
40-49	207	9.7
50-59	256	27.18
60-69	36	17.81
70-79	28	9.34
80-84	8	0.85

grade 2 had been present for 29.5 months, those of grade 3 for 35.2 months, and those of grade 4 for 14.7 months. This, of course, does not mean that epitheliomata of the activity noted had been present for the periods of time stated, but indicates rather the total duration of the lesions, many of which undoubtedly were originally benign. A number of the lesions of high grade unquestionably had been of lower grade primarily, but their activity had increased as a result of incomplete treatment or because of irritation. Many of the inactive growths had originated in areas of thickened leucoplakia, keratosis, inflammatory ulcers and traumatic scars and only recently had become active. Many patients with such lesions had come to the clinic on account of some entirely different conditions and the lesion of the lip was noted during the course of the general examination. A number of these lesions had not been considered of particular consequence by the patients, and advice concerning them would undoubtedly not have been sought for a considerable time under other circumstances.

ETIOLOGY

The conditions attributed by the patients in this series as causes of the disease were much the same as those usually assigned to epithelioma of the lip. Chronic irritation from smoking and exposure to the elements was outstanding. Exposure to the sun and wind was apparently the most important single irritative factor in the group, but as the majority of patients coming to the clinic are those whose work is largely in the open air, particularly farmers, the significance of this fact is less definite. Traumatic scars and recent trauma were factors in some instances. In others recurring fissures, leucoplakia, inflammatory ulcers, chelitis and benign growths of various types had been present on the lip for some time prior to the appearance of the epithelioma. A number of patients ascribed the development of

TABLE II—DISTRIBUTION OF LESIONS BY GRADE OF MALIGNANCY

Grade	Primary cases		Secondary or recurrent cases	
	Cases	Per cent	Cases	Per cent
1	4	26.7	97	4.27
2	206	33.7	204	3.39
3	47	8.2	74	8.97
4	3	1.4	3	3.5
Total	25		200	

their lesion to a cold sore which refused to heal. Many times no probable etiological factors could be elicited, the lesion occurring spontaneously and insidiously. Syphilis did not appear to have any direct bearing, contrary to the condition commonly observed in carcinoma of the tongue.

GRADING

Carcinoma of the lip vary greatly in their degree of activity or grade ranging from inactive to extremely active types. The majority of them are of moderate activity or of slow growth, most of them being of grade 1 or 2 according to Broders' classification. In this series 311 (33.01 per cent) of the lesions were graded 1, 492 (52.23 per cent) were graded 2, 121 (12.84 per cent) were graded 3, and 18 (1.91 per cent) were graded 4. It will be noted that more than 85 per cent of the lesions belonged to grades 1 and 2, and that a little more than half of them were graded 1.

As a rule the clinical appearance and the microscopic grading of the lesions correspond very strikingly. However the presence of acute infection and inflammation often change the clinical picture decidedly, causing the local lesion to develop more rapidly and to metastasize more actively without producing corresponding change in the histological characteristics. Many times growths which previously have remained practically stationary for a time will, as the result of an acute inflammatory process, flare into activity. This fact is apparently not appreciated by members of the medical profession generally, for many of the measures commonly resorted to for the early treatment of carcinoma of the lip are such as to induce inflammatory reaction.

The growths in this series varied from well localized indurated lesions, confined to a small portion of the lower lip to large, foul, fungating ulcerated masses measuring up to 7 or 8 centimeters in diameter involving not only the entire lower lip and chin, but at times extensively invading one or both cheeks and the upper lip as well.

In a number of instances there was attachment to the mandible and in a few cases extensive invasion of the bone was present. In several instances the growth was extending through the mental foramen and along the inferior dental canal for varying distances. Often, in addition to the primary lesion, there was marked enlargement caused by metastasis to the lymph nodes in the submaxillary, submental, and cervical triangles. In a few instances the malignant lymph nodes were broken down, and the overlying skin was involved.

CLASSIFICATION OF CASES—USE OF TERMS "PRIMARY AND SECONDARY" IN THIS PAPER

Because of the difference often noted between the behavior of untreated carcinoma of the lip and those previously treated, the two groups have been studied separately as well as together. For convenience the cases in which previous treatment had not been carried out are referred to here as primary and those in which active treatment had been carried out prior to the patients coming to the clinic as secondary. The primary group contains 552 cases (58.6 per cent), the secondary group 390 cases (41.4 per cent). Comparison of the activity or grade of the lesions comprising these two groups shows a greater number of lesions of grade 1 in the primary than in the secondary group, approximately the same percentage of lesions of grade 2 (moderately active growths) in both groups, and a higher percentage of lesions of grades 3 and 4 (more active growths) in the secondary group (Table II).

It will be noted that whereas more than 90 per cent of the primary lesions were of low-grade or moderate activity, only 7 per cent of the secondary lesions remained so. Also whereas approximately 9 per cent of the primary lesions were graded 3 and 4, this percentage was increased to 22 per cent in the secondary growths.

PREVIOUS TREATMENT

The matter of previous treatment is of the utmost importance in a consideration of epithelioma of the lip. The behavior of a previously untreated carcinoma is often quite different from that of one which is recurring following incomplete or inadequate treatment. Use of any agent which tends to produce an acute inflammatory reaction in the growth or in the tissues immediately about it without completely destroying the lesion is likely to be followed by increased activity with greater likelihood of metastasis. This agent may be accidental trauma, acute infection, undue exposure to the elements, especially actinic rays, or any radical therapeutic measure such as

irradiation, excision, electrocoagulation, the actual cautery, or escharotics.

All therapeutic agents are not equally prone to induce stimulation following inadequate application. It has repeatedly been observed at the clinic that increased activity of epitheliomata of the lip frequently follows inadequate treatment by radium and roentgen rays and that such recurrences are particularly difficult to control. The same observation also has been made relative to malignant growths of other portions of the mouth and face. Many of the patients in this series previously had received repeated irradiation. In fact irradiation had been the most common method of treatment used in these secondary cases prior to examination of the patients at the clinic. In 157 (40.2 per cent) of the 390 secondary cases in the series the patients had received either treatment with radium or roentgen-rays or both previously. Sixty three (40.12 per cent) of these 157 had received other treatment as well but the irradiation comprised the major portion of the treatment. In 139 cases (35.6 per cent) the patients had received applications of caustic substances or escharotic pastes. In 27 cases (6.9 per cent) treatment had been by the actual cautery or electrocoagulation, whereas in 67 cases (17.1 per cent), the lesion had been excised with either the scalpel or the cutting cautery. The high percentage of recurrences following previous irradiation and previous use of escharotic pastes is noteworthy. This may indicate more general use of these measures for treatment of carcinoma of the lip, lack of experience of the therapist consulted or a lower degree of efficiency of these agents as compared with other therapeutic measures.

As would be anticipated extension to lymphatic structures was encountered much more commonly in the secondary cases than in the primary cases. In the primary group of 552 cases involvement of lymphatic structures was found in 25 (4.5 per cent) whereas in the secondary group of 390 cases metastasis was present in 66 (17 per cent). It is interesting to note that metastasis had not occurred in a single case of the primary lesions of grade 1 whereas such extension had taken place in 4 cases in which lesions of grade 1 were present, and in which treatment had been carried out previously. The fact that only 14 primary lesions of grade 2 metastasized as compared with 29 of the secondary lesions of grade 2 is likewise noteworthy.

TREATMENT

The treatment of suspicious lesions of the lip carried out as a routine in the clinic was excision

either by removing a superficial elliptical portion, or a wedge wide of the lesion. If the lesion on the lip appeared clinically to be malignant a V shaped incision was made, the width of the excised portion depending on the size and apparent activity of the lesion. The tissue removed always was subjected to microscopic examination. If on examination it was proved to be benign further treatment was not required. If however on histological study the growth was found to be of a sufficiently high grade of malignancy that there was likelihood of metastasis dissection of the lymphatic structures in the submental and submaxillary triangles on both sides was carried out unless contra indicated because of the patient's advanced age or poor general condition. If the lesion was graded 1 its clinical appearance together with the matter of previous treatment, was taken into consideration in determining the type of treatment advisable for the lymphatic structures. Sometimes, depending on the extent of the carcinoma it was necessary to perform a plastic procedure at one or both angles of the mouth in order to reconstruct the lower lip. This was usually done by lateral incision through the angle of the mouth into the cheek, and removal of a wedge above in order to equalize the length of the upper lip. In this manner it is possible to rebuild the entire lower lip in one stage immediately following its removal for an extensive carcinoma or as a result of trauma. Immediate reconstruction is advisable only in case there is no attachment to the mandible, and the growth can be removed with a wide margin of normal tissue. When the tumor was attached to the mandible or was very active and extensive, it was either destroyed widely with electrocoagulation or was excised with the cutting cautery. The mandible was thoroughly cauterized at the site of attachment and the wound was left wide open except for suturing together the skin and mucous membrane at the margins laterally. Reconstruction of the lost tissues was delayed for from 6 months to a year depending on the extent and activity of the growth. In several cases of the group in which there was involvement about the chin and direct extension through the mental foramen and along the inferior dental canal cure was effected by carrying out thorough cauterization after the outer bony wall of the canal was removed with dissection of nodes subsequently. Of the 942 cases in which operation was performed simple excision was carried out in 760 (80.67 per cent). Excision and immediate plastic closure was done in 120 (12.7 per cent) of the cases and cautery excision or diathermy was necessitated

fair cross section of cases of carcinoma of the lip since in 97.55 per cent of the cases in which irradiation was not given the lesions were of grades 1 and 2 whereas in 90.6 per cent of cases in which irradiation was applied the lesions were of the same low grades of malignancy. Moreover 59.75 per cent of the former group and 43.78 per cent of the latter group were lesions of grade 1 which very rarely metastasize. In addition many of the patients were older than 70, and the likelihood of metastasis especially of such comparatively inactive growths, was still less on that account.

In cases of epithelioma of the lip in which operation was not considered because of the extent of the growth or because of the advanced age or poor general condition of the patient treatment was entirely by means of irradiation. In most of these treatment was looked on as a palliative measure.

SELECTION OF CASES FOR TREATMENT

The prognosis in epithelioma of the lower lip in which there is metastasis to the cervical nodes is entirely different than when the nodes are not involved. Comparison of the results obtained by different surgeons in the treatment of this group of cases is difficult because opinions will vary greatly concerning what constitutes an operable case. Whereas one surgeon may refuse to operate when more than one group of nodes is enlarged another will perform a radical operation even when there is fixation of a cervical mass. Obviously if more advanced cases are included in a given series, the percentage of cures will be lower. This accounts for the marked difference in results obtained in groups of cases reported from the same institution at different times. Simmons and Daland reviewing cases of this type in which treatment was instituted at the Massachusetts General Hospital between January 1, 1909 and January 1, 1919 found 28 per cent of 3 year cures whereas Shedden, when studying a similar group from the same institution from January 1, 1919, to January 1, 1923 noted 37 per cent of 3 year cures. The same is true in similar groups from other institutions. Sistrunk, reporting cases of this type in which operation had been performed at The Mayo Clinic during 1912, 1913 and 1914, found only 18.1 per cent of 5 to 8 year cures, whereas in the present series there is a percentage of 39.13 cures. As a matter of fact, as pointed out subsequently in a number of the cases in the present series the local lesion was so far advanced as was also metastasis to cervical nodes, that the patients might justifiably have been refused operation.

Simmons and Daland pointed out the obvious but not fully appreciated facts that the presence of palpable lymph nodes does not necessarily mean that metastasis has occurred, and the converse is also true. In fact in Shedden's series the nodes were palpable in 68 per cent of the cases before operation but of these carcinoma was present in only a fifth, whereas in 32 per cent the nodes were not palpable yet carcinoma was present in 10 per cent of them. These facts disclose the utter impossibility of comparing a group of cases in which epithelioma of the lip and palpable lymph nodes are present, and in which treatment is by means of irradiation, escharotic pastes or any other non-operative procedure, with a similar group of cases in which there was microscopically proved metastasis, and in which treatment has been surgical.

The outstanding contra indications to dissection of lymph nodes of patients with carcinoma of the lower lip are advanced age, poor general physical condition, and too extensive involvement. Metastasis is less likely to occur among patients of advanced years than among younger patients, because of changes in the lymphatic vessels and lessened activity of the lymphatic circulation. On this account dissection of lymph nodes is as a rule not advised for patients more than 70 years of age unless the patient's general condition is exceptionally good, and the lesion of the lip active. The mortality and morbidity from dissection of lymph nodes is very low and the patient's general physical condition rarely justifies withholding the procedure in cases in which it is otherwise indicated. Extensive involvement is the most common contra indication to surgical removal of the lymphatic structures. When clinically obvious metastasis extends to the base of the neck or beyond this, palliation only is likely to result following any type of treatment. The same is true when a metastatic mass in the neck is fixed to the mandible or attached to the carotid vessels, unless the lesion is of a low grade of malignancy. Often it is impossible to determine the operability of a cervical mass without surgical exploration. Sometimes a tumor that, on clinical examination appeared to be invading the jaw will be found at operation to involve the periosteum only and may be stripped off readily. Caution of the bony surface then affords a reasonable chance of controlling the disease in this region. If the lesion on the lip is highly malignant, and more than one cervical node is involved, many surgeons feel that dissection of lymphatic structures, however extensive, adds little to the prognosis. Some among them, in fact, have taken the

TABLE III—RESULTS OF EXCISION OF LABIAL LESIONS OF VARYING EXTENT*

Operation	(1)		(2)		(3)		(4)		(5)		
	Total patients	Traced		Lived 3 years or more		Lived 5 years or more		Lived 10 years or more			
		Patients	Per cent	Patients	Per cent	Patients	Per cent	Patients	Per cent		
Simple excision	58	46	81	41	88	27	29	64	14	5	50
Excision and immediate plastic reconstruction		85	83	61	75	20	41	65	15	4	33
Excision by cautery or diathermy (delayed plastic reconstruction)	48	41	85	4	10	10	1	8	27	58	

*The percentages in column (1) are related to the quantities in column (2) that is, 46 is 81 per cent of 58 and so forth. However the percentages in columns (3), (4) and (5) are not related to any other quantity expressed in the table. The significance of percentages in these columns can be perceived from an example, as follows: 41 is 88 per cent of that number of patients who underwent simple excision 3 or more years before the time of the study and so forth.

stand that surgical removal of the lymphatic structures is futile when there is definite clinical evidence of involvement.

MORTALITY FOLLOWING TREATMENT

The risk associated with the surgical removal of carcinoma of the lip is very slight. Even in extensive lesions in which marked dental infection is present among patients of advanced years, primary healing almost invariably occurs and complications of any sort are extremely unusual. It is rare that either the patient's age or general physical condition serves as a contra indication to operation. Although dissection of lymph nodes is not as a rule carried out if patients are more than 70 years of age there was no operative mortality among patients more than this age who underwent this procedure. In spite of the extent of the dissection required when the lymphatic structures are involved, the risk of operation is very low. Among the 942 cases in the series in which operation was performed, there were four postoperative deaths, a mortality of 0.42 per cent. Three of the patients were known to be very poor surgical risks. One of the 3, a man aged 75 years died of bronchopneumonia 17 days after excision of an extensive epithelioma of the lip and immediate plastic reconstruction under local anesthesia. Another of the 3 a man aged 65 years, died of myocardial insufficiency 3 days after removal of a lesion from the lip. At present, both of these patients would probably be treated by irradiation. The third patient, a man aged 62 years died of lobar pneumonia 11

TABLE IV—END RESULTS*

	Patients		Lived 3 years or more		Lived 5 years or more		Lived 10 years or more	
	Total	Traced	P. tentis	Per cent	P. tentis	Per cent	P. tentis	Per cent
Primary	435	363	310	87.88	217	80.37	10	43.1
Secondary	307	267	51	70.03	140	66.20	15	26.28

*See footnote to Table III.

TABLE V—DISSECTION OF LYMPH NODES WITH OUT INVOLVEMENT OF LYMPHATIC STRUCTURES*

	Patients	Per cent
Total	350	
Traced	308	85.70
Lived 3 years or more	283	90.83
Lived 5 years or more	210	80.74

*See footnote to Table III.

days after excision of the nodes and the growth on the lip at a single operation, this being the only death attributable to operation associated with removal of the lymphatic structures in 549 cases a mortality of 0.18 per cent. The fourth patient, a man aged 43 years died of erysipelas 3 weeks after excision of an extensive carcinoma of the lip with immediate plastic reconstruction.

RESULTS

Not only was extension to lymph nodes found in a much higher percentage of cases in the secondary group at the time of the original operation at the clinic, but later more of the patients in this group had recurrences either locally or in the lymph nodes. In only 13 (2.36 per cent) of the cases in the primary group did such lesions recur subsequently as compared with 41 (10.51 per cent) in the group of secondary cases. More over 17 patients (3 per cent) of the primary group died from the carcinoma of the lip, whereas 55 patients (14.1 per cent) of the secondary group died.

Since the method of surgical removal of the local lesion in cases of carcinoma of the lip depends largely on the extent of the growth, its activity and previous treatment the end results likewise will vary with the type of procedure carried out (Table III). The cases in this series in which simple V shaped excision of the local growth was done consisted of cases in which the lesions ranged to 2.5 centimeters in diameter. As would be expected the end-results in this group are more satisfactory than in those requir-

TABLE VI.—RESULTS OF EXCISION IN CASES IN WHICH LYMPH NODES WERE INVOLVED

	Patients	Per cent
Total	99	
Number dead from	45	94.9
Lived 3 years or more	21	49
Lived 5 years or more	15	30.5*
Lived 10 years or more	5	10.1

*See footnotes to Table III

ing immediate or delayed plastic reconstruction, since the group includes earlier growths and a higher percentage of lesions of low grade. In many of the cases in which delayed reconstruction was necessary growths involved the entire lower lip and at times one or both cheeks, and the upper lip as well. In addition, fixation to and involvement of the mandible was present at times.

The end-results in the secondary cases as compared with those in which the lesion of the lip had not been treated previously (primary cases) are noteworthy. These are shown in Table IV.

A review of the statistics pertaining to the cases in which the nodes were not involved reveals that 91.88 per cent of the patients lived for 3 years or more and 80.74 per cent lived for 5 years or more following operation (Table VI).

Of the 25 patients who died less than 3 years after operation only 11 (44 per cent) died from recurrence of the malignant process. Eleven of the patients in the group are known to have died of causes other than epithelioma of the lip or nodes, whereas in 3 cases (12 per cent) the cause of death was indeterminate (Table VI).

The average length of life of patients with involvement of submental or submaxillary nodes who died within 3 years was 18.96 months, and for those with involvement of the cervical nodes, 12 months. Nine patients of this group treated during 1928 and 1929 were still living when last heard from in 1931.

One of the principal reasons for undertaking this study was to determine the value of irradiation used to supplement surgery in these cases, and whether irradiation used before operation was more effective than when used after removal of the nodes. The results are shown in Table VII.

These groups are made up of consecutive cases, including both primary and recurrent lesions. It will be noted that whereas in the group treated with surgery alone practically 83 per cent of the patients were well for at least 3 years and 79 per cent for 5 years or more in the group in which irradiation supplemented surgical measures 85 per

TABLE VII.—METHODS OF TREATMENT*

	Patients	Per cent
I. Surgery without radiation		
Total cases	128	
Treated	124	96.87
Lived 3 years or more	201	61.99
Lived 5 years or more	100	30.74
II. Surgery with postoperative radiation (radium or roentgen ray)		
Total cases	909	
Treated	421	88.37
Lived 3 years or more	274	81.46
Lived 5 years or more	169	50.54
III. Surgery with pre-operative radiation and postoperative radiation, if lymph nodes involved		
Total cases	545	
Treated	313	86.94
Lived 3 years or more	187	57.79
Lived 5 years or more	156	83.29

*See footnotes to Table III

cent of the patients were well for 3 years or more, and 80.5 per cent for 5 years or more. The difference of approximately 1 per cent in the 3 year group and of 1.5 per cent in the 5 year group seems surprisingly small, although irradiation would naturally be used in a higher percentage of the less favorable group. The group in which radium treatment was used prior to dissection of lymph nodes reveals some further improvement in the results, however, there being practically 88 per cent of 3 year cures and 84 per cent of 5 year cures. This latter group thus reveals a 5 per cent advantage over the purely surgical group, both as regards the 3 and the 5 year cures.

In the following group of 187 cases (Table VIII) the local lesion was excised but the nodes were not removed either because of the inactive nature of the growth, or because of the advanced age or poor general condition of the patient. In 192 of these cases, radiation therapy was given over the regional lymphatic structures whereas in the remaining 95 cases the lymphatic structures received no treatment.

Three of the patients are living from 3 to 5 years after removal of an involved mental node. The two who are dead lived for 3½ and 3 years, respectively following the operation.

The group in which treatment was entirely by means of irradiation included 31 patients, all of whom received either roentgen therapy or radium, with distance and screening over the regional lymphatic structures and radium on an applicator or as an unscreened plaque to the lesion of

the lip, except for a few cases in which seeds or needles were implanted into the local lesion. The ages of the patients ranged from 42 to 89 years. Most of them were of advanced years the average age being a fraction over 75 years. One patient of the group could not be traced. Of the 30 traced 29 (96.6 per cent) are dead. One is living and free from recurrence 6½ years from the time treatment was applied. This patient was 86 years of age at the time he came to the clinic with an epithelioma 2.5 centimeters in diameter on the lower lip. Of the 29 patients who are dead death in all probability was due to carcinoma of the lip or lymph nodes in 22 (75.8 per cent). In 7 (24.1 per cent) cases death resulted from other causes. These 7 patients were known to be free from recurrence for from 2 to 5½ years following treatment. The average length of life of the patients who died of epithelioma was a little more than 2 years (26 months).

The effectiveness of surgery supplemented with radiation in controlling the malignant process in some of the cases in which involvement was extensive is evident from the 3 reports of cases which follow.

CASE 1. A man, aged 37 years, came to the clinic November 3, 1924, with an extensive, recurring epithelioma of the lower lip that had been treated with an escharotic ointment a year previously. The growth involved three-fourths of the lower lip and appeared very active clinically. An obviously malignant node 3 centimeters in diameter was present in the submental region. The lesion of the lip was excised with a wide V shaped incision and plastic reconstruction was made at each angle of the mouth to reconstruct the lip. Microscopically the lesion proved to be a squamous cell epithelioma of grade 3. Eleven days later complete bilateral dissection of the anterior cervical triangle was made. In addition to the malignant submental node, moderately advanced involvement of the deep cervical lymph nodes and submaxillary nodes on the right was found. The surgical note stated that involvement was extensive and the prognosis poor. About a year later the patient returned with a fixed malignant node 2.5 centimeters in diameter opposite the mental foramen on the left side. This was destroyed with diathermy. The patient has now been well for more than 7 years.

CASE 2. A man, aged 65 years, came to the clinic June 15, 1925, because of an extensive epithelioma that involved the full thickness of the lower lip and extended approximately 5 centimeters lateral to the left angle of the mouth. The lesion previously had been irradiated twenty times,

TABLE VIII.—EXCISION OF EPITHELIOMA OF LIP RESULTS IN RELATION TO IRRADIATION AND RESECTION*

	Total patients	Patients traced	Patients dead	Lived 3 years or more		Lived 5 years or more	
				Patients	Per cent	Patients	Per cent
Without dissection or irradiation of lymph nodes	95	8	67.85	68	83.0	21	75.60
Without dissection of lymph nodes but with irradiation	103	60	90.6	140	83.8	96	73.28

*See footnote to Table III.

and there was fixation of the growth to the left side of the mandible anteriorly. Several enlarged nodes were present in the left submaxillary region, the largest measuring 3 centimeters in diameter. The primary growth was excised widely by cautery June 16, 1925, and the mandible at the area of fixation was thoroughly cauterized. Microscopically the growth was a squamous cell epithelioma of grade 3. At the same time radium emanation points were inserted into the large node in the submaxillary region. Following this the patient was given approximately 6000 milligram hours of radium over the neck and left cheek. Approximately 3 months later bilateral submental and submaxillary nodes were dissected with a block dissection on the left. Extensive malignant involvement of the left submental and submaxillary nodes and the left submaxillary salivary node was found. The surgical note at the time of operation stated that the prognosis was very poor. Roentgen treatment was given over the neck prior to dissection. The patient was living and well when last heard from 3 years and 4 months after the dissection.

CASE 3. A man, aged 47 years, came to the clinic August 15, 1928, with an extensive, very active appearing epithelioma involving almost the entire lower lip well down into the labial fold. The lymph nodes on both sides of the neck were greatly enlarged, and clinically appeared to be involved. The lesion of the lip was excised widely with cautery August 16, 1928, and microscopically proved to be a squamous cell epithelioma graded 3. The following day bilateral submental and submaxillary dissection of lymph nodes with block dissection on the left side was done. The nodes were involved in the left submaxillary and upper deep cervical regions. One of these nodes had broken down, and liquefied carcinoma escaped into the wound. The surgeon's note at the time of operation stated that the patient's condition seemed hopeless. Roentgen treatment was given subsequently. The patient was living and well when last heard from, 3 years and 3 months later.

DIOTHANE IN SURGERY OF THE ANAL CANAL¹

A CLINICAL SURVEY OF ONE HUNDRED CASES

CURTICE ROSSER, M.D. F.A.C.S. DALLAS, TEXAS

IN our experience a modified low spinal anesthesia has proved an entirely safe and eminently satisfactory procedure for anorectal operations, its presenting advantages being early and uniform action together with a complete sphincteric relaxation which permits non-traumatic visualization of the field (8). Nor have we been convinced that any of the chemical combinations suggested are safer or more effective than procaine crystal subarachnoid anesthesia.

Unfortunately perfect surgical anesthesia is too often quickly followed by a distressing period of sphincter spasm, pain and inability to void which provides the patient with reminiscent material for the years to come. This reaction is at present modified by hot applications, hot sitz baths, and analgesics given orally but no proctologist can be so complacent in the premises as to deny interest in any device which offers to prolong the period of local insensibility and possibly eliminate this stage of acute sphincter hypertonicity.

Previous reports on the pharmacology and clinical action of diothane—the new diphenylurethane derivative—suggest that its toxicity is near that of procaine that it is slowly absorbed after tissue infiltration with a consequent prolongation of anesthesia (5, 6, 7) and that favorable results have been obtained in urologic (1, 4), ophthalmologic (3) and nose and throat procedures (9) where this chemical has been used as an anesthetic agent by infiltration and topical application.

The present report summarizes a 4 months experience in which the agent was injected in anal and perianal tissues in one hundred instances, the lesions present being hemorrhoids (50 cases), fissures (40 cases) together with 10 instances of miscellaneous minor lesions. We regard local infiltrations of fistulae as unsafe.

Diothane is apparently chemically incompatible with spinal fluid—it has not been tried as an intrasacral injection. Except in rare instances it would appear unwise to produce prolonged and complete sacral plexus paralysis. Final conclusions are not here offered as to the topical efficacy of the agent in the anal canal—our brief experience permits the tentative suggestion however that cocaine is not sufficiently toxic in the very small amounts necessary to anesthetize painful anal lesions to counter-

balance what appeared to be its greater and more immediate effectiveness.

All patients were given small preliminary doses of some barbiturate as animal experiments have indicated that this drug has a similar protective action preceding diothane to that discovered in connection with cocaine and procaine (7). No greater amount than 1 ounce of the anesthetic was used in any one case and in the majority a dilution of $\frac{1}{2}$ of 1 per cent was found to be optimum, except where a few cubic centimeters of 1 per cent was used in marginal lesions.

HEMORRHOIDS

Twelve cases of thrombotic external piles and integumentary marginal tags were operated upon as office patients after infiltration of approximately 2 cubic centimeters of 1 per cent diothane in each case. It was immediately found that the injection was associated with a sharp burning pain definitely greater than the discomfort of procaine injection. The pain was momentary however and after a 5 minute period anesthesia was perfect in each instance. The period of anesthesia varied from 6 hours in one case to 4 days in another; the majority of the patients stated that sensation returned so slowly after a period of several days, that they were unable to determine the dividing line. Postoperative swelling was not marked and was permanent in none of this group.

A more varied experience is recorded in connection with internal piles. Thirty-eight patients were operated upon under diothane infiltration alone or diothane infiltration locally as an adjunct to a low subarachnoid anesthesia. The latter was found preferable from the standpoint of operative relaxation.

As controls, a series of 30 unselected and consecutive cases in which patients were operated upon under spinal anesthesia alone was compared with the first 30 hemorrhoids in which diothane was used. Table I presents a summary of the two series. All hemorrhoids were removed by a ligature and excision procedure. It will be noted that the type of spinal anesthesia used (35 milligrams of procaine in 10 minims of spinal fluid) affords a period of local insensibility of from 1 to 2 hours, the usual period being 1 hour and 25 minutes. Where diothane was injected such uniformity was

TABLE I—SUMMARY
A Hemorrhoidectomy Diothane Infiltration

Case	Additional anesthesia	Duration anesthesia hours &	Morphine	Codeine	Catheter	Complication
	Spinal	16	1		0	0
1	Spinal	5	0	1		0
2	Spinal	24	4	0	0	Tags
4	Spinal	7	1	1	2	Tags
5	Spinal	1		3	2	0
6	0	72	0	0	0	Tag
7	0	8	0	1	0	0
8	Spinal	15		1	1	0
9	Spinal	8			0	0
10	Spinal	2			0	0
11	Spinal	14			0	0
12	Spinal	7	0	2	0	0
13	0	45	0	0	0	0
14	Spinal	7	0		2	0
15	Spinal	5	2			0
16	Spinal	7	0	0	0	0
17	Spinal			2	2	0
18	Spinal	72	0	0	0	0
19	Spinal	2	0		2	0
20	Spinal	12			0	0
21	Spinal	1	1		0	0
22		8	0	1	0	0
23	Spinal	2		1	0	0
24	Spinal	7	2	0	0	Superficial infection
25		72	0	0	0	0
26	Spinal	2		2	1	Abscess
27	Spinal	2	2	1	1	Tag
28	Spinal	9		2	0	0
29	Spinal	2		2	0	Tags
30	Spinal					Superficial infection
Summary	20 Spinal Diathane alone	5	Morphine 0 Morphine 1 Morphine	20 (66.6%) 9 (16.6%) 5 (16.6%)	Catheter Catheter Catheter	12 (73.2%) 1 (6.6%) 3 (16.6%)

1st First narcotic.

*First 24 hours

B Hemorrhoidectomy Spinal Anesthesia Alone

Average duration anesthesia, hour	5 minutes	Complications
Morphine first 24 hours	Catheter first 24 hours	Stricture
Morphine 0	Catheter 0	Fistula
Morphine 2 6 (20.0%)	Catheter 1 1 (16.6%)	Infection
Morphine 2 11 (36.6%)	Catheter 1 7 (58.3%)	Tags
Morphine 3 9 (30.0%)	Catheter 3 1 (3.3%)	Total
Morphine 4 4 (13.3%)		6 (20.0%)

absent. In 7 instances the return of sensation was in less than 2 hours and as these 7 required morphine or were catheterized or both it was believed that the drug was for some technical reason ineffective in this group. In the remainder the

period of anesthesia was prolonged for several hours to several days and the amount of discomfort and spasm during the first 24 hours as measured by morphine administration and catheterization was definitely decreased.

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¹From the Section on Proctology, Baylor University School of Medicine. Read before the Texas Surgical Society, Dallas, February 1931.

the possible value of this new anæsthetic agent in the special field investigated. No doubt further experience will establish a technique offering more uniform results. Lateral nerve block in hæmorrhoidectomies or infiltration under all operative wounds as the last step of a procedure performed under a low spinal anæsthesia were each satisfactory.

The chief objections noted are pain when the drug is introduced without previous anæsthesia, an increased tendency to 'tag' formation after hæmorrhoidectomy and the occasional development of local abscess, apparently chemical in nature.

Diothane is compatible with procaine and the combination of the two is suggested if an operation in the anal region is to be performed under infiltration alone. We are also of the opinion that an isotonic solution to replace the distilled water carrier should relieve immediate burning and possibly prevent chemical abscess. The one half per cent strength appears optimum.

Since this contribution was submitted (May 1934) further experience in a second hundred cases, in which procaine mixtures for very minor procedures and one half per cent isotonic solution of diothane in the remainder have been

used throughout, has tended to confirm the conclusions noted. No constitutional reactions have been noted, initial burning has been decreased but not eliminated by adding procaine to the mixture or the use of a preliminary infiltration of procaine, tag formation has continued to be noted in a modest percentage of cases but abscess has not been encountered when isotonic solutions were injected.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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NOVEMBER, 1934

TOTAL THYROIDECTOMY FOR HEART DISEASE

THE prolonged discussion at the recent Toronto meeting of the American Surgical Association concerning total thyroidectomy¹ emphasizes the possibility of this new therapeutic measure. Following the suggestion of Blumgart and Levine that removal of the thyroid gland might prove of value in the treatment of intractable heart disease, some two hundred cases have by now been subjected to this procedure. The original impetus toward this undertaking emanated from both the laboratory and the clinic. Blumgart's careful and valuable studies concerning the factors controlling the rate of blood flow played a large rôle in arriving at the determination to perform thyroidectomy for his experiments showed that the rate of blood flow was in a fairly constant relation to the basal metabolic demands of the body. Blumgart studied normal individuals and individuals in many pathological states.

¹Master, Charles G. Klemm, Herman L. and Berlin, David D. Results of 4 months experience with total ablation of the thyroid for various functions and congestive heart failure. *T. Am. Surg. Ass.* 934.
Lettler, Elliott C. and Schmetzer, Max T. Total thyroidectomy for cardiac patients. *T. Am. Surg. Ass.* 934.

These studies indicated that when the basal metabolic rate was elevated (as in Graves disease) the rate of blood flow was increased and conversely when the basal metabolic rate was lowered (as in myxedema) the rate of flow was decreased. Reasoning from these findings and knowing that the rate of flow in intractable heart disease is slowed and indeed cannot be elevated in some cases by drug therapy it appeared that, if the basal metabolic demands might be lowered by thyroidectomy then these demands might find even with the slowed rate of flow in decompensated heart disease an adequate circulation. With the demand thus being dropped to meet a fixed rate of supply a certain equilibrium would be established and patients might be brought into compensation.

Another aspect of the reasoning which suggested removal of the normal thyroid gland for decompensated heart disease is wrapped up in the many and varied clinical observations of thyroid patients amassed during the last fifty years. By means of clinical studies we have been able to set aside from the great mass of cardiac cripples that group now commonly called thyrocardiac. In this group are those patients in whom the cardiac disability is due to repeated bouts of thyrotoxicosis. It has been demonstrated that such patients when submitted to subtotal thyroidectomy show an almost miraculous restoration to a practically normal condition. These patients often manifest auricular fibrillation and both clinical and experimental observations have shown that under the stress and strain of thyrotoxicosis auricular fibrillation is a common occurrence. But our

clinical observations relate not only to these obvious cases of thyroid intoxication for further reasoning is seen in the general attitude of both physicians and surgeons who place little reliance upon the basal metabolic rate as an indication of thyroid activity. For example, Wilson, in a study of patients with cardiac irregularities, has been able to make the diagnosis of thyrotoxicosis (Graves' disease) long before the basal metabolic rate has become elevated. Still further the thyroid gland has been attacked in cases of tachycardia with benefit to the patient and as one searches the thyroid literature of the last twenty years one finds more observations which definitely demonstrate a relation between cardiac activity and thyroid function not always measurable in terms of the basal metabolic rate.

The studies now reported from the Peter Bent Brigham Hospital and the Beth Israel Hospital of Boston seem to demonstrate a fulfillment of the predictions originally made by Blumgart and Levine. Patients in decompensation whether from arteriosclerotic heart disease or valvular disease, have been greatly benefited by total removal of the normal thyroid gland. In the first cases studied subtotal thyroidectomy was performed but long continued observation showed that eventually as the thyroid function was replaced apparently by a regrowth of the tissue and as the basal metabolic rate was restored to normal the improvement disappeared.

It does seem as if in the group of cardiac decompensation cases, the benefit which results is in definite relation to the lowered basal metabolic rate. Many bedridden patients have by now been submitted to this procedure and, as their basal metabolic rates have fallen and thus the demands upon the circulation decreased, they have finally reached a point where the lowered demands

find even in the crippled cardiac situation an adequate supply.

Of particular interest are the results reported in patients suffering from angina pectoris. For example, in this group the circulation is already adequate and the benefit which has been achieved may not be in relation to the lowering of the basal metabolic demand. This is of great interest and may exemplify the growing tendency in both physicians and surgeons to separate as functions of the thyroid gland (1) the factors which dictate the basal metabolic demands and (2) the factors which seem to bear a definite relation to circulatory changes irrespective of the basal metabolic demands. The studies reported by Cutler and Schnitker showed that in the angina pectoris group there were many people in whom the relief of pain bore little relation to the basal metabolic rate. Their observations revealed an immediate reduction in the amount of pain occurring many weeks before the basal metabolic rate fell. They showed also that many of these patients could be fed thyroid extract and their basal metabolic level brought practically to normal without return of pain. In extenuation of their belief that the factor controlling the basal metabolic rate is quite separate from the factor dealing with the circulation manifestation they discussed the experimental results of Shambaugh who showed that adrenalin apparently is an important factor in the production of cardiac pain. This relation of adrenalin they thought was affected by thyroidectomy and they reported that patients in whom anginal attacks had been provoked by the subcutaneous injection of adrenalin failed to show pain when a similar amount of adrenalin was injected immediately following total thyroidectomy and at a time when the basal metabolic rate was still normal. It appears from these studies that possibly the basal

metabolic rate is not the best or only measuring stick for the effect produced upon the circulation by total thyroidectomy. The relief afforded seems to be due in part at least, to a diminished adrenalin activity associated with the loss of thyroid gland secretion.

The operation of total thyroidectomy as now performed carries certain dangers, chief ly those due to deprivation of the parathyroid function by removal of these glands (i.e. tetany etc.) and injury to the recurrent laryngeal nerves. Apparently, parathyroid tetany has not proved to be a serious obstacle since no one has reported grave cases of tetany. It should be impressed on others, however, that the surgeons working with this problem have taken great precautions, including even histological examination of all questionable tissue at the time of the operation in order to leave the parathyroids in the patient or if they have been removed to replace them in the pretracheal or sternomastoid muscles. Moreover the knowledge that the feeding of viosterol and calcium lactate by mouth can largely counteract the effects of parathyroid deprivation may give us greater confidence in the treatment of patients in whom these important structures may be injured or removed. The matter of injury to the recurrent laryngeal nerves has also been given particular attention and those surgeons most interested in this procedure have settled upon the use of local anesthesia (procaine one per cent) in order that the patient may talk during that part of the procedure when the recurrent nerves are exposed and therefore in danger of injury. With complete exposure of the recurrent nerves and adequate haemostasis it is apparent that this difficulty can be overcome.

There is, over and above the addition of this new therapeutic measure in the treatment of heart disease, a psychological shift

which indicates a departure in surgical undertakings of considerable moment, for here we have an operation deliberately planned and undertaken for the relief of a pathological viscus in which that viscus itself is not approached. This operation which plans to relieve the heart consists in the attack upon a perfectly normal structure and almost for the first time we see the surgeon with full appreciation of physiology carrying out a physiological rather than an anatomical operation. As science gives us knowledge we can hope that other procedures aimed not at the diseased part, but at parts controlling the function in the diseased organ may be further elaborated. Thus by shifting a little the activities of Nature we shall see Nature herself adjust the diseased organ to a more desirable activity and condition.

ELLIOTT C. CUTLER

METALAPAROTOMY FUNCTIONAL ILEUS¹

THE importance of the adynamic ileus which occurs following every laparotomy is not sufficiently appreciated. This ileus, which may be termed "functional" results either from direct trauma to the intestine or from stimulation of the splanchnic nerves which are inhibitors to the gut. As has been shown repeatedly both experimentally and clinically manipulation and exposure of the abdominal viscera to air cause an inhibition of intestinal movement and loss in tone. That such an inhibition exists for a period of time after operation is not generally appreciated, however, and it is the failure to recognize this ileus which is frequently responsible for a disturbed convalescence. As in all types of ileus, there is in addition to the decrease in tone and movement of the gut a diminished

¹From the Department of Surgery School of Medicine, Tulane University, New Orleans.

absorption from, and an increased secretion into, the intestine. The intestinal tract is functionally inactive. This type of ileus should not be confused, however, with the adynamic ileus which is associated with peritonitis, although the two differ only in degree and extent.

The duration of this physiological ileus varies considerably and is dependent largely upon the amount of intra abdominal trauma during the operation. Normally in cases in which there is relatively little intra abdominal operative manipulation, such as occurs during the removal of the appendix for a chronic appendicitis the functional ileus persists for from six to twelve hours. If during this period of time the gastro-intestinal tract while functionally inactive, is kept empty and not overloaded by the administration of fluids or food either by mouth or by rectum the gut rapidly regains its tone and movement.

There may be no clinical manifestations of metalaparotomy functional ileus. Occasionally, however, nausea and vomiting are present, although these are not marked unless fluids or food have been allowed. The prognosis is good if the gastro-intestinal tract is allowed to regain its tone before the ingestion of substances. Altogether too frequently the anesthesia is blamed for the postoperative nausea and vomiting even though it may be a contributory factor.

In the treatment of postoperative functional ileus it must be realized first that such a condition exists. As the gastro-intestinal tract is functionally unable to receive any material it is imperative that absolutely nothing be given by mouth, water and even more emphatically sweetened drinks which are apt to produce abdominal distention as a result of fermentation should be avoided. Morphine should be administered liberally

after operation (in the case of an adult unless some contra indication exists the patients should receive one fourth grain of morphine sulphate every four hours whether they complain of pain or not) because as has been shown repeatedly both in the laboratory and in the clinic, morphine increases the intestinal tone and does not inhibit the gut as is commonly thought. The morphine should be continued as long as there are any signs of ileus. All patients who have had an abdominal section should have a heat tent applied to the abdomen, because as has been shown by Mueller, the application of heat to the abdomen causes a dilatation of the somatic vessels and a concomitant contraction of the splanchnic vessels. Associated with the contraction of the splanchnic vessels there is a decreased secretion into and an increased absorption from the gut and an increase in the tone of the gut wall. Heat applied to the abdomen, therefore is beneficial in preventing and in combating ileus.

In those cases in which operation has been done on the gastric, the upper intestinal, and the biliary tracts there frequently occurs an increase in gastric, intestinal and biliary secretions. Because of this it is imperative to empty the stomach and upper portion of the intestine of its secretions in order to prevent stagnation and overdistention of the gut. This is best accomplished by means of continuous suction through an indwelling duodenal catheter as suggested by Wangenstein and Bartlett. The duodenal aspiration should be continued as long as there is any evidence of increased secretion and stagnation, or during the period of pyloric imbalance (Bartlett).

As the metalaparotomy functional ileus persists usually only from six to twelve hours it is possible after this period of time to allow the administration of fluids by mouth. These

should consist of hot water, hot tea, or fat free broth. If these are tolerated the patient's diet can be increased rapidly so that on the second or third morning unless there is continued irritation of the peritoneum the patient can usually tolerate a full diet. Sweetened drinks should not be allowed for approximately a week because of the fermentation and intestinal distention which they are apt to produce. If metapneumonia functional ileus is considered and observed the incidence of postoperative distention will become markedly diminished and even abolished except in those cases with peritonitis in which there is a continued peritoneal irritation.

ALTON OCHSNER.

VIVISECTION

THE subject of preservation of the right to use animals for experimental purposes is again before us in an acute form. We are informed that there is to be an organized effort to outlaw vivisection. The American

College of Surgeons is prepared to combat with all of its energy any movement that has for its purpose interference with the progress of scientific preventive and curative medicine.

The College contemplates the publication of a synopsis of the advantages of and necessities for a continued use of animals for medical purposes—some for purely experimental purposes, and some for biologic assays of drugs and pharmaceuticals, preparation of sera and vaccines, biologic tests, teaching of surgical procedures etc. This publication will be widely distributed where it is thought the greatest good may be accomplished in counteracting the attempts to cripple the medical profession and endanger the lives of the entire population.

Attention is directed particularly to the article entitled *Health Benefits from Animal Experimentation* which will be found on pages 835 to 840 of this issue of *SURGERY GYNECOLOGY AND OBSTETRICS*.

FRANKLIN H. MARSH

EARLY AMERICAN MEDICAL SCHOOLS

THE MEDICAL SCHOOL OF THE UNIVERSITY OF LOUISVILLE

IRVIN ABELL, M.D. F.A.C.S. LOUISVILLE, KENTUCKY

THE history of the Medical School of the University of Louisville is closely linked with that of Transylvania Medical School since the organization of the former was largely effected by members of the faculty of the latter who desired the greater facilities afforded by Louisville over those then existing in Lexington. Transylvania University was established in Lexington, Kentucky in 1780 in 1799 a medical school was added with the appointment of Drs Samuel Brown and Francis Ridgely as professors therein. From 1799 to 1817 various appointments were made in the medical department and partial courses of lectures delivered. Following this year the school entered upon a remarkable career of service. In addition to Drs. Brown and Ridgely its faculty embraced a coterie of other brilliant teachers, among whom are found Benjamin Winslow Dudley internationally known surgeon, James Bush pioneer lithotomist, William Hall Richardson the erratic but brilliant Charles Caldwell, John Esten Cooke known for his humoral theory of disease and his heroic dosage of calomel therefor, Daniel Drake, who with Samuel Brown was a great internist of his day. Brown in 1802 four years after Jenner announced his discovery of vaccination, having vaccinated more than 500 patients, Constantine Samuel Rafinesque, world known botanist, Charles Wilkins Short, a botanist of national repute, L. P. Vandell Sr. chemist, forceful writer and accomplished speaker, sire of a distinguished generation of Kentucky doctors, Robert Peter who performed a greater number of reliable detailed, practically useful analyses of the soil than any living chemist of his time, John Eberle, teacher and writer of medicine, Thomas D. Mitchell, teacher in the schools of Kentucky and Philadelphia, Nathan Ryno Smith who later returned to Baltimore where, as surgeon and teacher in the University of Maryland he established an enduring fame, William Short Chipley, distinguished alienist, and others of lesser attainments. During the 39 years of its active existence the medical school taught 4,656 pupils and con-

ferred the degree of doctor of medicine on 1881 of that number, a contribution in medical education of the day of incomparable value. The library of Transylvania today contains one of the rarest collections in this or any country of books and manuscripts published during the seventeenth and early part of the eighteenth centuries. The Medical School of the University of Louisville when founded was known as the Medical Institute of the City of Louisville (Fig. 1) a charter being secured from the State Legislature with the assistance of Dr. Alban Goldsmith, a former associate of Dr. Ephraim McDowell. The law authorizing the establishment of the 'Institute' was approved on February 2, 1833. Section 6 of the original act is interesting in that it provided for clinical instruction, an advanced step at this period of medical education. Section 6 That the trustees of the Louisville Marine Hospital may confide the medical department of said hospital to the Institute and the Mayor and Council of the City of Louisville may confide the medical department of the poor house and hospital to said Institute. The difficulty in securing

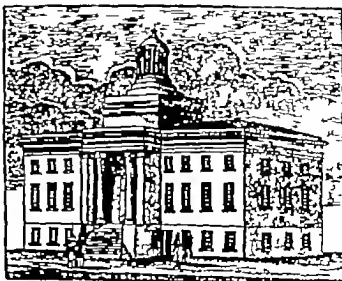


Fig. 1 The Medical Institute of the City of Louisville January 1, 1833.



Fig. 1. Daniel Drake, 1796-1852



Fig. 3. Professor Samuel D. Gross, 1803-1874 (From photograph made in 1860)



Fig. 4. Dr. Austin Flint, Sr., 1822-1886

medical teachers of recognized ability combined with the lack of adequate financial backing continued to delay the opening of the Institute. Because of Louisville's strategic river location, rapidly increasing size and consequently greater clinical facilities, six members of the Transylvania Medical Faculty, during the first part of the 1836-37 session discussed and apparently unanimously agreed upon the advisability of its removal to Louisville. This action precipitated a rather acrimonious fight involving the faculty, the trustees, and the citizens of Lexington which had as one of its results the opening of the Louisville Medical Institute in 1837 with the following faculty: Henry M. Miller, a graduate of Transylvania, professor of obstetrics and diseases of women and children; Charles Caldwell, a graduate of the University of Pennsylvania, professor of the institute of medicine and clinical practice and medical jurisprudence; John Esten Cooke, a graduate of the University of Pennsylvania, professor of the theory and practice of medicine; Lunsford Pitts Vandell, Sr., a graduate of Transylvania, professor of materia medica, lecturer on chemistry and dean of the faculty; Joshua Barker Flint, a graduate of Harvard, professor of surgery; Jedediah Cobb, a graduate of Bowdoin, professor of anatomy. At the close of the first session Dr. Charles Wilkins Short of Transylvania assumed his duties as professor of materia medica and medical botany while Vandell became professor of chemistry and pharmacy. At the opening of the third session Dr. Daniel Drake (Fig. 2) then internationally known, accepted the professorship of clinical medicine and pathological anatomy. During his stay in Louisville he completed his

monumental work, 1 *Systemic Treatise Historical, Etiological, and Practical on the Principal Diseases of the Interior Valley of North America as they appear in the Caucasian, African, Indian, and Esquimaux Varieties of its Population*. He had devoted more than 30 years to the preparation of this work, the first volume of 878 pages illustrated with nineteen plates appearing in 1850 and the second one of 985 pages in 1854.

On April 23, 1846, the University of Louisville was founded with two departments, the department of medicine and the department of law and by amendment of the charter the Louisville Medical Institute constituted the Medical Department. In 1846, Dr. Joshua B. Flint resigned as professor of surgery and was succeeded by Dr. Samuel D. Gross (Fig. 3), a graduate of Jefferson Medical College (1828). With the exception of one year, 1850, when he was professor of surgery in the University of the city of New York, during which time the chair in Louisville was filled by Dr. Paul F. Eve, Dr. Gross remained as head of the surgical department for 16 years. During this time under the stimulating influence of his leadership, assisted by his colleagues in the University, notably Daniel Drake and Austin Flint (Fig. 4), Louisville became the leading medical center of the West. Most of the work on his monumental system of surgery was done during these years. His work on *Diseases, Injuries, and Malformations of the Urinary Organs* was published in 1851 followed by that on *Foreign Bodies in the Air Passages* in 1854.

During the greater part of the past century the system of medical education consisted of apprenticeship and attendance upon lectures. There



Fig 5 The present Medical School building.

were but few hospitals, medical literature was in its infancy and the advantages and opportunities afforded by the medical societies of today were unknown. The professors in the medical colleges were the accepted leaders, hence men of ability sought such positions as a means of winning recognition and distinction. With such conditions prevailing it was but logical that with the growth of Louisville as a medical center the number of men aspiring to teaching positions became so great as to result in the establishment of new schools. The Kentucky School of Medicine was founded in 1850, the Louisville Medical College in 1863, the Hospital College of Medicine in 1873, and the Medical Department of Kentucky University in 1898. The list of men who taught in the five schools is a long one the writer would select the following as distinctive classifying them by

their spheres of activity. Deans J M Bodine, W H Wathen, C W Kelly, P R Taylor and T C Evans. Surgery and Clinical Surgery J B Flint, S D Gross, P F Eve, B R Palmer, D W Yandell, A B Cook, R O Cowling, Tobias G Richardson, W O Roberts, H H Grant, W L Rodman J M Holloway A M Cartledge, Turner Anderson, L S McMurtry, Joseph Matthews, and W H Wathen. Medicine Austin Flint, Charles Caldwell, Daniel Drake John E. Cooke, T S Bell, L P Yandell, James W Holland, Samuel Bemiss, John A. Ouchterlony W H Galt, George Warner, E D Force, Lewis and Coleman Rogers, William Bailey, F C Wilson J B Marvin, John G Cecil and P B Scott. Obstetrics and Diseases of Children Henry Miller, John E. Crowe John Hardin, Theophilus Parvin H B Ritter, W H Bolling, J A Ireland, H E.



Fig 6 Louisville City Hospital, 1934

Tuley Anatomy Jedediah Cobb J W Benson
J D Burch, G W Bayless, C W Kelly, and
J M Bodine. Physiology H M Bullitt, E R
Palmer Sam Cochran Chemistry L D Hosten-
bune, Benjamin Silliman Ophthalmology otology
and laryngology Dudley S Reynolds, M F
Coones, J M Ray William Cheatham, T C
Evans, P R Taylor Dermatology I N Bloom

Of these Drs Samuel Gross, Theophilus Parvin
James Holland, and William Rodman removed to
Philadelphia. Dr Austin Flint to New York, and
Drs Tobias Richardson and Samuel Berniss to
New Orleans, in which cities they enjoyed dis-
tinguished careers as leaders in the profession.
These men taught during a transition period and
were the connecting links between the old and new
eras. With the advent of the laboratory the
growth of biology chemistry and physiology and
the development of the modern hospital medicine
ceased to be empirical, became more and more a
science, and medical education conformed to the
inevitable change. In 1908 these five schools were
merged into one under the title of the University
of Louisville School of Medicine. With the union
of the various schools the building which had been
used by the Louisville Medical College, located on
First and Chestnut Streets, was taken over and
has served for the teaching of the preclinical sub-
jects up to the present time (Fig. 5). In 1925 an
agreement was made between the City Fathers
and the Board of Trustees of the University of
Louisville whereby the professional work of the
Louisville City Hospital, an institution of 400
beds (Fig. 6) was placed entirely under the direc-
tion of the School of Medicine. Previous to this
agreement the faculty of the medical school was

appointed to serve in the hospital only during the
school year during the summer months other
physicians were appointed by the Board of Public
Safety to care for the sick. All of the various
services necessary for the adequate care of
patients and for teaching together with offices for
full time clinical faculty are housed in this
hospital.

In 1930 teaching affiliations were made with the
Waverly Hills Tuberculosis Sanatorium, a modern
charitable institution with a capacity of 440. It is
located some seven miles outside of the city and
the students live and work there during a few
weeks of their training. In 1932 an affiliation
similar to that with the Louisville City Hospital
was made with the Children's Free Hospital (75
beds) which has facilities for the care of medical,
surgical and orthopedic cases. This hospital is
across the street from the City Hospital, an ideal
situation for the proper distribution of patients
between the two institutions. In this same year
responsibility for the maintenance and develop-
ment of the Psychological Clinic, which had been
conducted for about ten years by an organization
of the Community Chest, was assumed by the
Psychiatric Department of the School of Medi-
cine. The out-growth is the Mental Hygiene
Clinic, housed on the grounds of the Children's
Free Hospital. Shortly afterward the department
of public health and bacteriology of the medical
school assumed control of the department of
epidemiology of the City Health Office and in
1934 it took over the City's Department of
Bacteriology. Such arrangements preclude polit-
ical interference and allow easy access to teaching
material.

It will be seen that the School of Medicine, through its affiliations, has 915 beds for purposes of instruction. There are available to the students in addition, 150,000 dispensary patients a year. The faculty at the present time consists of 127 members, 65 of which are of professional rank, of these 17 are on a full-time basis. The minimum requirement for admission is 60 semester hours of collegiate work as fixed by the Association of American Medical Colleges. The classes are limited to 90 students each and the average enrollment in the school is 350.

The University of Louisville, as a municipal institution receives by law 5 to 7 mills of the taxes collected by the city, but this covers not

more than 35 per cent of the total operating expense. The remainder is paid from endowments, donations, and student fees. The University, which began with the School of Medicine in 1837, added during the succeeding years the School of Law in 1846, the College of Liberal Arts in 1907, the School of Dentistry in 1918, The Speed Scientific School in 1924, and the School of Music in 1932. At the present time the enrollment for the entire University is in the neighborhood of 1800 students.

The author wishes gratefully to acknowledge the aid of Dean John Walker Moore and Dr. Clarence Bird, head of the department of surgery in the compilation of the above data.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE excellent text on *Surgical Anatomy* by Callander is broadly conceived and well carried out. The author's purpose has been to present anatomic facts in terms of their clinical importance, "to produce a book which would be explanatory and utilitarian rather than encyclopedic." The difficulty of such an undertaking is at once appreciated by anyone who has attempted to teach surgical anatomy, a course which is too often either entirely anatomy or entirely one of surgical technique. To be quite truthful, it is not always easy to say just what surgical anatomy is, anyway. Dean Lewis feels that the two subjects of surgery and anatomy are so inseparably bound together that in his preface to the volume he writes: "In medical schools the surgical department should hold itself responsible for the proper approach to gross anatomy. For that matter so should the departments of internal medicine, ear, nose and throat, eye, obstetrics and gynecology and all other departments."

Callander succeeds in the task he set out to accomplish. The book is made up in ten sections, each covering a definite region of the body. In each section, the region is further divided into subdivisions, each of which is taken in turn and discussed from the anatomical and then from the surgical standpoint. The book is replete with excellent illustrations, many new and many reproduced from numerous sources. The selection of these illustrations is most happy in that not only do they represent anatomy but surgical procedures which emphasize the importance of the anatomy. The text is clear, brief and readable. Despite its rather large size and expense, the book is to be recommended to students as well as to the surgeon.

MICHAEL L. MCGOW

IN this work¹ on physical therapy, Wolf has gathered together the results of his experience in all branches of physical therapy during his 30 years of medical practice. The book is packed full of useful information and is a valuable textbook on this important branch of therapy.

The author believes that routine treatment in physical therapy is a dangerous procedure, im-

practical, and inefficient, and that physical therapy must be used on its merits alone. He has therefore made a special effort to tell why he uses a certain method in a specific case.

Dr. William Bierman, director of physical therapy, Beth Israel Hospital, New York, has written excellent chapters on the therapeutic use of hyperthermia and minor electrosurgery. The use of physical agents in diseases of the lower respiratory tract is considered in a chapter by Dr. Adolph A. Lilien, associate physical therapist, Mt. Sinai Hospital. Physical therapy in otolaryngology is the subject of a chapter by Dr. Farel Jourd, adjunct physical therapist, Mt. Sinai Hospital.

The first part of the book by the author is devoted to a consideration of the theory and principles of physical therapy with a specially valuable chapter on hydrotherapy. Dr. Wolf has had a long experience in the use of this valuable agent, and he rightly states that hydrotherapy can be practiced on a far better and safer scientific basis than can the majority of our medications.

In part 2 which discusses the practice of physical therapeutics, Dr. Wolf has carefully given the technique for the use of physical therapy in the various diseases and injuries in which it is indicated. He gives conservative discussions of the uses of physical agents and quotes illustrative cases.

The last chapter on the use of physical agents in gynecology is by Dr. Madge McGuinness, chief of clinic, Department of Physical Therapy, Vanderbilt Clinic, and director of physical therapy, Misericordia Hospital, New York.

This book can be recommended as an excellent textbook for the student and general practitioner.

J. S. COCHRAN

WHENEVER a new volume on surgery is forth coming from any of the great German clinics, the American profession has been accustomed to anticipate something well worthwhile. In the recent work² of Dr. Payr we are not disappointed; it represents practically the life work of a man who is eminently qualified by his vast surgical and clinical experience, under conditions of war and peace to speak with authority on his chosen subject.

In the introductory chapter Dr. Payr states that he intended originally to present only the technique

¹PHYSICAL THERAPY. By C. LARRY CALLANDER, A.B., M.D., F.A.C.S. With Foreword by DAVID LEWIS, M.D., F.C.P. (L.D.) F.A.C.S. Philadelphia and London: W. B. Saunders Co., 1932.
²TEXTBOOK OF PHYSICAL THERAPY. By HERMANN F. WOLF, M.D. Foreword by L. F. BAUER, M.D. New York and London: D. Appleton-Century Co., Inc., 1933.

GRUNDLEICHES UND GELBEHRENDEN. By Professor Dr. ERNST PAYR. Vol. I.—Führungslehre, Biologie der gesunden Pathogenese und pathologische Anatomie der Akute Infektion, Klinik, Diagnostik und pathologische Anatomie. Berlin: Julius Springer, 1924.

of plastic surgery in ankylosis. Soon, however he found that this could not be covered thoroughly without including a résumé of the pathogenesis and pathological anatomy of ankylosis and in particular the indications for surgery, because upon proper selection of cases depends the successful management, by whatever therapy.

The original plan contemplated the conclusion of the first volume with the general operative technique, but as the work proceeded the scope of the subject became so vast that this section, together with special operative procedures, has been left for a second volume, although in many places reference has been made to operative management. Dr Payr has viewed the problem of reconstruction of the joint in ankylosis from every conceivable angle, and has given a complete dissertation on each phase, thus presenting in one volume all the essential principles of the study of plastic surgery in ankylosis. We may look forward to the second volume, wherein operative procedures will be considered, with equal anticipation.

He has given us, in great detail the consideration of the pathological anatomy, physiology, histology and mechanical anatomy of the joints. His subdivisions of the problem are many. He discusses congenital and accidental factors, septicæmia, the ankylosis due to inactivity, infection, and asepia, and such co-existing factors as arthritis, gout, tuberculosis, and lues. The chapters devoted to animal experimentation in its application to plastic surgery on man, are exceedingly interesting. Here he studied the production of ankylosis, with the resultant pathological, histological, and anatomical findings, and he carried the work forward to observations on the physiological regeneration of the joints of the joint capsules and ligaments, and of the synovia.

Of great practical interest is the discussion of methods of investigation from the standpoint of diagnosis, wherein are enumerated clinical and bacteriological laboratory studies, the interpretation of X-ray findings, and the evaluation of these investigations in the diagnosis and prognosis.

His theories on the regeneration of the joint as a whole and in part are sure to arouse widespread discussion among men in this country who have been working along similar lines, as many of his concepts are entirely new to us. Particularly apropos at this time is his discussion of arthritis in relation to ankylosis, and the question of focal infection, endocrine influence, and general constitutional factors.

The book is beautifully illustrated. For the man who reads it in the original German, it will be a treasure trove on behalf of the great majority who do not read German, the hope is expressed that when it comes to translation, as it unquestionably should, it falls into the hands of someone who will do it justly.

As it is to be expected there is an elaborate and altogether satisfactory index.

WILLIAM A. HYNOWICKS.

IN the introduction to *Some Aspects of the Cancer Problem* W. Blair Bell states—It is clear that Man can survive in the progress of evolution only so long as his intellect and accumulated knowledge are sufficient to enable him to overcome the physical and mental stresses and injuries that follow in the wake of civilization, and can deal successfully with the host of organic pathological processes that may prey upon him. Is our intelligence great enough, and our store of knowledge sufficient to enable us to conquer this menace (cancer)? If they are, mankind will endure for another season if they are not, we can hardly foresee what fate may be in store for the human race.

Man has made an unrelenting fight against cancer during the past hundred years, the problem being approached in many ways nevertheless there is an apparent increase in cancer prevalence. Comparatively little attention has been addressed to the spread of cancer, especially in the form of a careful study of the character of the metastatic lesion and the fate of cancer cells when deposited in foreign soil. Willis, in a carefully prepared monograph¹ adds a distinct chapter to our present knowledge of this important phase of the cancer problem. He states in the preface of this work 'No comprehensive account of the mode of extension and metastasis of tumours is available. Textbooks of pathology touch but lightly on the subject and ignore many of the problems presented by it, and special works on oncology view tumours chiefly from the aspect of their primary origins and not from that of their metastatic destination. Much experimental work has been devoted to a study of the fate of tumour cells artificially injected in various situations in animals. In the spontaneous metastasis of tumours, nature displays to us in the human being a great variety of such experiments already performed and presenting a series of end-results the meaning of which it is our task to interpret. It may be that this interpretation, heretofore but little assayed, may uncover some of the secrets of neoplastic growth.'

Willis bases his conclusions upon a careful study of 323 personally conducted autopsies in cases of malignant disease and upon a most painstaking investigation of the literature, his bibliography covering 83 pages. A synopsis of the autopsy protocols is given in an appendix. The book is divided into two parts. Part I is devoted to the consideration of the general aspect of the spread of tumors and Part II to secondary neoplastic tumors of the individual organs and tissues. Many interesting avenues of thought are opened in the consideration of these topics, two of which impressed themselves upon the reviewer. The care in deciding whether a tumor is primary or secondary especially when a surgical removal is being contemplated and the vagaries displayed by blood borne tumor cells. It is a strange incongruity that tumor cells rarely grow to form metastatic neoplasms.

MONOGRAPH OF THE BAIRD INSTITUTE OF MEDICAL RESEARCH,
THE SPREAD OF TUMOURS IN THE HUMAN BODY. By Robert A. Willis,
M.D. B.S. D.Sc. London: J. & A. Churchill, 1934.

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² *TEXTBOOK OF PHYSICAL THERAPY*. By HERMANN F. WOLF, M.D. Foreword by L. F. BAKER, M.D. New York and London: D. Appleton-Century Co., Inc., 1932.

² *GRUNDRISSZUG DER CHIRURGIE*. By Professor Dr. ERICH PAYR. Vol. I—Pathologische Anatomie der Leber, Gallenwege und peritoneale Anatomie der Leber, Gallenwege, Harnblase und Harnleiter. Berlin: Julius Springer, 1934.

considered as a whole rather than as individual substances with particular properties and special techniques. A brief discussion of the theory of narcosis precedes the practical considerations. The chapter dealing with functional and organic changes produced under anesthesia is particularly detailed. The directions as to the selection of anesthetic agents and the techniques for their administration are not sufficiently complete or detailed to serve as a practical guide in the management of narcosis. A series of diagrammatic tables is presented, however

which graphically indicates the clinical manifestations during the successive stages of narcosis with some of the more frequently used anesthetics. A history of anesthesia introduces the work, but many of the dramatic qualities of the story are lost in the telling. Furthermore numerous minor misstatements limit the value of the historical review. Because of the difference in the type of reader for whom the work is intended, this book will probably find little use as a practical textbook in this country.

LEO M. ZIMMERMAN

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

GENEALOGY OF SEX. SEX IN ITS MYRIAD FORMS, FROM THE ONE-CELLED ANIMAL TO THE HUMAN BEING. By Curt Theising, M.D. Translated by Eden and Cedar Paul. New York: Emerson Books, Inc. 1934.

THE DANGEROUS AGE IN MEN. A TREATISE ON THE PROSTATE GLAND. By Chester Tilton Stone, M.D. New York: The Macmillan Company 1934.

THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George E. Gask, C.M.G. D.S.O., F.R.C.S. (Eng.) and J. Paterson Ross, M.S. (Lond.) F.R.C.S. (Eng.) Baltimore: William Wood and Company 1934.

A TEXTBOOK OF BACTERIOLOGY. etc. By Hans Ziemer, M.D. and Stanhope Bayne-Jones, M.D. 7th rev. ed. New York and London: D. Appleton-Century Co. 1934.

LABORATORY MANUAL OF BIOLOGICAL CHEMISTRY, WITH SUPPLEMENT. By Otto Folin. 5th ed. New York and London: D. Appleton-Century Company 1934.

FÜHR UND BEI, IHRE ERKRANKUNGEN UND DEREN BEHANDLUNG. By Prof. Dr. med. Georg Hohmann. 3d ed. Munich: J. F. Bergmann, 1934.

POSTURES AND PRACTICES DURING LABOR AMONG PRIMITIVE PEOPLES. ADAPTATIONS TO MODERN OBSTETRICS, etc. By Julius Jarcho, M.D., F.A.C.S. New York: Paul B. Hoeber Inc., 1934.

CANCER. EDINBURGH 1934. Published by The Cancer Control Organisation for Edinburgh and Southeast Scotland. Edinburgh: E. & S. Livingstone, 1934.

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AMERICAN COLLEGE OF SURGEONS

HEALTH BENEFITS FROM ANIMAL EXPERIMENTATION

ISSUED BY THE AMERICAN COLLEGE OF SURGEONS PREPARED BY BOWMAN C. CROWELL, M.D.

IT is interesting to stand in the concourse of one of our large railway stations and watch the people who pass through it. How few bowed legs we see and how few are pock marked! What clear eyes they all have! How few hunchbacks there are and how few show disfiguring scars on the neck! Compared with conditions in this country at the turn of the last century and in some foreign countries at the present time, this picture indicates an immense progress in the control of rickets, smallpox, trachoma, and tuberculosis of the spine and of the glands of the neck.

Each of us demands that our family physician shall be able to prevent sickness and at any cost shall do the most possible for us when we do get sick. It is impossible for him to take preventive or curative measures, surgical or otherwise, without using knowledge that has been gained from work on lower animals—mice, rats, guinea pigs, rabbits, dogs, monkeys, birds, horses, cows, and other animals. The drugs and other remedial agents that he uses are tested and standardized on animals. Many of his diagnostic tests are performed on animals. His surgical technique has been perfected on them. New knowledge of practical value in health as well as in disease comes from them and must continue to come from them. Many of the protective and curative agents are manufactured within their bodies. Moreover the benefit to animals themselves has been as great as has that to human beings. Epizootic diseases have been controlled and preventive and curative measures have saved the lives of millions of animals. Now let us see what progress has been made by the use of animals and how it has been accomplished.

First we will go to the admitting office of one of our large hospitals and watch the stream of patients passing through. See the poor thin pale, nervous man with severe anemia going in to see the medical man who will restore his color and strength with liver, the fat woman who has over indulged at the table and has avoided exercise now suffering from diabetes, the nervous excitable

woman with bulging eyes and a lump in her neck, a case of exophthalmic goiter, the poor dyspeptic with an ulcer of the stomach, the woman with the lump in her breast, and the line of young children coming in to go through the process of protection from smallpox, typhoid fever, diphtheria or scarlet fever or to have their teeth and tonsils attended to in order to prevent future heart or kidney disease.

Preventive and curative scientific medicine can do much for them all. It can give promise of life to the case of pernicious anemia to whom fifteen years ago we could offer little more than pity, a great discovery, that came as a climax to research which was started purely as a laboratory investigation into the coloring matter of the blood. Science can enable the diabetic to live a normal life after proper education in diet and the use of insulin. It can relieve the goiter case and it can cure the stomach ulcer. Beaumont, a U. S. army surgeon, in 1825 had a patient who had been shot through the stomach and it was necessary to establish a permanent opening between the stomach and the abdominal wall. He seized this opportunity to study the process of digestion directly for the first time it had been done and the results were of great importance. But how much more easily this can be done now on animals! We know that the lump in the breast can be removed and possible cancer prevented or early cancer cured. We also know that the children will be protected against many needless diseases by the preventive measures now so readily employed.

Let us move on to the laboratory and see the doctor examining the sputum for tuberculous bacilli, the smear from the throat for diphtheria bacilli, the blood serum from the patient for evidence of typhoid fever or syphilis, or relapsing fever, the intestinal contents for blood, mucus, amebae, round worms, flat worms or other parasites, the spinal fluid for evidence of infantile paralysis or other derangements of the nervous system, the stomach contents for evidence of ulcer or cancer, the tissue from the breast for

cancer or other tumor, the urine for evidence of nephritis or diabetes and see him preparing the diagnostic and curative sera and vaccines for a number of diseases.

Next let us go to the pharmacy where the digitals for heart trouble, the insulin for diabetes, the stock vaccines and sera, the castor oil and the viosterol the Epsom salts and the soda bicarbonate are dispensed along with all the other drugs. Here let us pause and think that none of these preparations that are used so commonly would be safe to give to a patient unless they had been purified and standardized as to dosage or sterility by trying them on animals and determining their unit values.

A visit to the department of operative surgery in the adjoining medical school will be of great interest. Novitiates in medicine who already have studied their chemistry biology, anatomy physiology pathology and bacteriology are being led by competent and experienced surgeons into the realm where they may become familiar with the appearance and feeling of living tissues and are learning the surgical technical methods of cutting suturing ligaturing preventing infection and bandaging so that they may be fitted to save lives in emergencies. Here also we see the experienced surgeon, who has had an idea of some new surgical procedure that he thinks may be feasible, trying it out on some animal and perfecting his technique before attempting to cure the baffling human case that has been entrusted to his care. We will see the animals anesthetized, sterilized, and cared for with every precaution so that the outcome of the various procedures may be known without the occurrence of complications. On the wall are posted instructions as to the care of the animals. It is in rooms such as this that surgeons within very recent years have learned how they may open the skull and treat many diseases of the brain, how they may sever nerve roots to relieve intolerable pain, how they may sew up the ruptured heart or remove a diseased lobe of the lung how they may remove the spleen or sew up the liver after a severe crushing accident, and also how to improve upon many older surgical procedures.

The anatomical structure and functional activities of many of the organs of the dog are so similar to those of man that it makes its use almost imperative in some studies. However there is a voluntary restriction of its use by medical scientists to those cases in which some other animal would not serve the purpose as well or nearly as well.

Over at the veterinary station we will find all

sorts of animals benefiting from the experimental work. Animals are subject to many of the same diseases as are humans, and their methods of prevention and treatment are similar. Moreover, the control of diseases that are peculiar to animals is as great an accomplishment as has occurred with human diseases. In serving others they have served themselves. In dogs distemper can be prevented and rabies can be reduced. In cattle tuberculosis easily can be detected and eliminated. Parasites can be removed. Anthrax tetanus, and hog cholera can be prevented. All of these diseases have caused untold suffering and economic loss which research has made needless as, for example in hog cholera which in 1914 killed 12 per cent of the swine in the United States, and against which it is now possible to obtain nearly 100 per cent protection.

What is worse than a rabid dog? What gives greater fear than the bite of a mad dog? Through the Pasteur treatment the dangers of hydrophobia have been reduced enormously, and the number of persons now annually treated for this disease mounts to the almost unbelievable number of hundreds of thousands. How many would hesitate thus to protect themselves after being bitten by a rabid dog even with the knowledge that their individual case will entail the sacrifice of several animals?

Having witnessed these evidences of progress, and knowing of much else that cannot be included in detail in a limited space—the great reduction in infant mortality and the control of infectious diseases the purification of our water, milk, and food, which we all take for granted and by reason of which we continue to exist, the progress in the control of cancer, and the increase in the life span from 45 to 59 years within the past 35 years with the prediction that it will be increased still further—let us pause a moment to consider some of the factors that have served to bring all this about.

If this preservation of health and increased longevity are to be continued then the use of animals must be allowed. Physicians have not hesitated to sacrifice themselves in experiments for the progress of science or to prove their theories. Very recently we have the example of Dr. Park of New York and his associates allowing themselves to be injected with the killed virus of infantile paralysis in order that their bodies might produce substances that would protect others against the disease. And still more recently Dr. Kolmer of Philadelphia has tested on himself and his two children what he believes to be a preventive against infantile paralysis. James

Carroll of the Walter Reed Yellow Fever Commission submitted himself to the bite of a mosquito infected with the yellow fever virus and came successfully through an attack of yellow fever. Not so fortunate was his fellow member on the Commission, Jesse W. Lazear who was accidentally bitten by an infected mosquito during their experiment and died from the disease. Noguchi is another notable example of a martyr to science. Daniel Carrion Dutton Ricketts, and McClintic all lost their lives in investigating the diseases with which their names are associated.

Sir Frederick G. Banting proved his theory and developed insulin at the sacrifice of approximately thirty dogs. Today the lives of a million people have benefited from its use. John B. Murphy in perfecting his method of sealing together the torn or cut ends of the intestine by an ingenious button used fifteen or twenty dogs, and as a result countless human lives have been saved.

Such examples could be multiplied almost *ad infinitum*. We know that the medical scientists unselfishly have made possible all the progress of which we have spoken. We discern the unreasonableness and inconsistency of those who would hamper it when they daily eat fish flesh or fowl. We know the human and humane character of our medical fraternity who will sit up night after night with you when you need them and we also know the conditions under which they practice animal experimentation.

Let me refer to only a few of them with reference especially to dogs. Only derelict or condemned dogs from the pounds are so used, and not the pets of ourselves or our friends or even of our enemies. In order to be allowed to obtain dogs for experimental purposes an institution first must submit to thorough investigation before approval is given.

Laboratory workers have drawn up sets of rules for the care of the dogs and these are adhered to rigidly. The dogs really live lives of luxury compared to ordinary street life. Cages and runways are kept clean and airy and are sterilized at regular intervals. Food is especially prepared for them in diet kitchens, from which recently has come much of our knowledge of the all essential vitamin contents of our foods. Before most operations they are anesthetized and if to be sacrificed are killed painlessly. After operations their care is as important in the result of the work as is the operation itself. The affection that develops between a dog that has been experimented on and his surgeon is sufficient evidence of the lack of cruelty.

But what can be said of the cruelty of the persons who seek to hamper medical progress which promises a still greater saving of life, greater prolongation of the life span and greater relief of suffering by placing restrictions and hindrances about those who are devoting themselves to human and animal welfare?

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GELATINOUS CARCINOMA OF THE BREAST¹

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ONE reason why the breast has been called the mother of surgical pathology is the protean character of mammary cancer. Although cancer of the breast is basically a disease entity it is really not one but many diseases. The diffuse duct carcinoma, the bulky adenocarcinoma, the intra-cystic or intraductal papillary carcinoma, the acute inflammatory carcinoma, the sweat gland carcinoma and Paget's cancer are all varieties of mammary cancer yet they differ greatly in their clinical and pathological characteristics. A rare and interesting subvariety is the gelatinous carcinoma of which we have had the opportunity of studying 30 cases.

Gelatinous degeneration of tumors has long been of speculative interest, since 1816 when Otto first described gelatiniform carcinoma of the stomach. The first accurate histological study was made by Johannes Mueller. Gelatinous degeneration is more common in malignant neoplasms of the digestive tract and generally occurs in regions covered over in the normal state by an epithelium which secretes mucus. Its occurrence in the breast is rare and excites interest because this organ does not normally secrete mucus, nor are its cells mucigenic in appearance. The gelatinous carcinomata of organs other than the breast e.g. of the rectum and stomach have a relatively low degree of malignancy growing slowly and metastasizing late in their course. In this

respect they resemble the gelatinous carcinomata of the breast.

Gelatinous carcinoma has been variously named as gelatiniform carcinoma (Billroth) carcinoma myxomatodes (Dixon), myxoid carcinoma, mucoid or mucous carcinoma, colloid carcinoma, carcinoma gelatinosum and carcinoma mucosum. The term "colloid" cancer should be abandoned in favor of gelatinous carcinoma, which designation is more truly descriptive.

INCIDENCE

Gelatinous carcinoma is a rare variety of mammary cancer. The incidence is uniformly given by many authors as 1 to 2 per cent of all cancers of the breast. We were able to discover only 30 (1.56 per cent) gelatinous carcinomata in a histological review of 1922

TABLE I—INCIDENCE OF GELATINOUS CARCINOMA IN THE BREAST

	Per Cent
Gaube 49 in 1,944 mammary cancers	1.66
Lange 17 in 1,814 mammary cancers	0.93
Lee, Hauser and Pack 30 in 1,922 mammary cancers (personal cases)	1.56
Lee, Hauser and Pack 144 in 10,355 mammary cancers (collected cases)	1.39
Lewin and Reinhold 12 in 950 mammary cancers	1.3
Valherbe 7 in 336 mammary cancers	2.14
Schmidt 1 in 85 mammary cancers	1.22
Slimmonds 4 in 1,200 mammary cancers	0.33
Spangenthal 20 in 638 mammary cancers	3.13
Stout	1.1
Warren and Witham 3 in 162 mammary cancers	1.85

Read before the Surgical Section, New York Academy of Medicine, October 5, 1934.

Deceased.

mammary cancers. Cheate and Cutler believe this tumor to be more common than generally supposed basing their conviction on the use of whole serial sections of the breast and so discovering gelatinous degeneration in tumors in which its presence was totally unsuspected. In our opinion the purely gelatinous carcinomata, recognized grossly as such are of great rarity although gelatinous degeneration of parts of any of the varieties of breast cancers may not be so infrequent.

CLASSIFICATION

Gelatinous carcinomata of the breast are logically subdivided into two distinct groups based on physical findings, clinical course gross and microscopic pathological anatomy.

1 *Primary gelatinous carcinoma in which the gelatinous features predominate.* The gelatinous element presumably arises *de novo* with the onset of malignancy in a pre-existing papillary cystadenoma. This type occurs usually in patients of advanced age. It is of extremely slow growth and may exist many years before it is suspected to be carcinomatous. The absence of skin adherence and nipple retraction, the encapsulation of the tumor and the infrequency of metastasis confirm the relative benignity of this variety of mammary cancer. The tumor has the gross appearance of a gelatinous or mucous cyst and under the microscope the epithelial elements are few and scattered. These encapsulated gelatinous carcinomata have sometimes been cured by local excision although this treatment is not recommended as a routine procedure.

2 *Ordinary carcinoma of the breast with secondary gelatinous degeneration.* The bulky adenocarcinoma of the breast, which has a tendency to undergo spontaneous degenerative changes is the histological type most frequently involved. The ductal carcinomata may show similar though less marked gelatinous changes. The gelatinous character of the tumor may or may not be grossly discernible. It may be recognized in some tumors only by microscopic examination and then found to involve only a portion of the carcinoma. We have the impression that the gelatinous degeneration is an incidental occurrence in these

cancers, which may retain their full degree of malignancy. We have observed gelatinous degeneration in a carcinoma of the breast in which other parts were anaplastic and highly malignant (Fig. 4). This group of gelatinous carcinomata of the breast have no distinguishing clinical or pathological characteristics. They may occur in patients of all ages; the rate of growth, degree of malignancy, tendency to metastasize and physical signs produced are the same as for ordinary mammary cancers of the same histological classification. The gelatinous degeneration originates in either the connective tissue or epithelial elements of the tumor or both. This origin can not be determined in many cases. These subdivisions have been classified as follows:

a. *Myxoid carcinoma.* A variety of gelatinous carcinoma of the breast in which the gelatinous changes arise by metaplasia in the connective tissue, i. e. it becomes myxomatous.

b. *Mucoid carcinoma.* A variety of gelatinous carcinoma of the breast in which the gelatinous material originates directly from the carcinoma cells.

GROSS PATHOLOGICAL ANATOMY

The classification which we have adopted for gelatinous carcinomata of the breast takes full cognizance of the marked difference in the gross appearance of these tumors. The type classified as showing secondary gelatinous degeneration in any of the histological varieties of mammary cancer has practically no distinguishing gross characteristics. The wholly gelatinous carcinomata of the breast on the other hand constitute a definite clinicopathological entity. We shall confine our description largely to the encapsulated purely gelatinous tumor.

The encapsulation of the tumor and the freedom of the skin, nipple, and breast fat from invasion after years of growth may confuse the diagnostician. Ewing states that the small and wholly gelatinous neoplasms in the breast may be mistaken for simple mucous cysts and their carcinomatous character may be overlooked. To the naked eye such a tumor may be readily confused with myxoma.

A cross section of these round nodular tumors may reveal numerous tiny concretions



Fig. 1. Encapsulated multilocular gelatinous carcinoma of the breast. The tumor is intersected by thin fibrous strands to form compartments of variable size.



Fig. 2. Hemorrhage and liquefaction necrosis in a gelatinous carcinoma of the breast. The locules are small and the tumor exhibits greater growth activity than the specimen seen in Figure 1. It is partially encapsulated but is adherent to the pectoral muscles.

especially in the center of the cancer which may resemble the corpora amylacea of the prostate and are seldom larger than 130 micra in diameter (Olivier). The contents of the encapsulated tumor are juicy and gum like with the consistence of firm jelly, trembling on the knife. The gelatinous substance is not fluid enough to flow but it can be readily extruded from the locules, by gentle pressure between the thumb and finger.

The color of the tumor is variable depending on its vascularity and the presence or absence of degenerative changes. The pure gelatinous content is a lustrous light greenish gray or occasionally yellow, but if hemorrhage and fatty metamorphosis occur, the gelatin assumes an opaque dull brown appearance. Some of the tumors have been described as pearly pink pale orange wine, or chocolate color resembling coagulated blood. When a thin cross section of the tumor is held to the light it may resemble a section from a colloid goiter (Reel). Numerous small blood vessels

can be seen ramifying in the delicate walls of the large and small locules, a factor which contributes to the frequency of hemorrhagic changes in the tumor and variance of color from pink to chocolate. This is one of the chief points of difference between gelatinous cancers of the breast and of other organs such as the stomach. The grayish gelatinous tumors may contain small reddish brown hemorrhagic spots throughout their substance thus rendering them less translucent than normal.

The tumor is intersected or honeycombed with thin fibrous strands of white trabeculae disposed in a reticular arrangement, forming meshes or compartments of variable size (Fig. 1). The presence of this cloistering of the tumor into locules or loges is uniform in this variety of gelatinous carcinoma. The connective tissue septa may also be translucent and occasionally myxoid. The cystic cavities are lined with a smooth thin membrane. The individual locules vary in size from 1 millimeter to 1 centimeter (pin head to pea). The larger tumors have correspondingly larger



73 74 75 76 77 78 79
Fig. 3 Gelatinous degeneration of a bulky cystadenocarcinoma.

cavities. The center of the tumor is the most nodular portion and toward the periphery the nodules or locules become smaller and more opaque (Fig. 2).

PATHOLOGICAL HISTOLOGY

The gelatinous carcinomata are found usually in the group of bulky adenocarcinomata and intracystic papillary carcinomata and less frequently in the ductal and small round cell carcinomata of the breast. The gelatinous element may so dominate the microscopical picture that the particular histological type of cancer is obscured.

The epithelial cells comprising the carcinoma show great variability in size depending on

their location in the tumor and the degree of degeneration. Some of the degenerating cells contain mucin in small transparent droplets (Fig. 7) while other cells are so distended by the mucin that the remnant of nucleus is barely visible. The translucent intracellular mucin occupies more space than the unaltered protoplasm which no doubt accounts for the globular swelling of these cells. Other cells are oval and contain atypical large ovoid or spherical nuclei; we have not observed the elongated nuclei which Lebert characterized as typical. Cells with arborescent nuclei are occasionally found in the center of the cell nests. The younger cells in the outer or marginal gelatinous locules have many nucleoli and most of the cell content is comprised of nuclei. The older cells are paler and have ill defined borders. The cytoplasm of the epithelial cells often seems hyaline but in other cases is involved in granular and fatty degeneration.

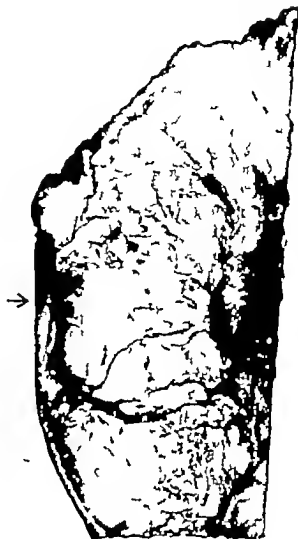
In the typical or wholly gelatinous cancer of the breast the minute architecture of the tumor is so distorted that no well defined picture can be painted. The cells may appear in cylindromatous arrangement or in isolated tubular or alveolar islands in a sea of mucus. These tubules or alveoli may be distended with mucus while others appear as inactive well differentiated and well preserved epithelial clusters. The membrana propria of the acini and ducts is early destroyed. The cells are still preserved in some locules, in others they are disappearing and finally in others they have completely disintegrated leaving only cellular skeletons in the center of the lobule (Fig. 6). In the oldest loculi the content is almost exclusively mucus with little or no trace of the carcinoma cells. Larrey reported the case of a recurrent mammary cancer weighing 2,300 grams, which was completely gelatinous as no cancer cells could be found on microscopical examination. As a rule, some epithelial cells can be found if diligent search be made. These cells are separated from the connective tissue stroma by the intervening mucus. The degeneration of these cells is seemingly due not only to pressure atrophy by the mucus but also to their isolation from a nutritive source and possible in-

terference with the process of diffusion by the enveloping oedematous mucus.

The gelatinous layer is smaller in the peripheral layer or margin of the tumor, and is most abundant in the older acellular central part. The typical gelatinous carcinoma of the breast is carcinomatous only in its peripheral portion with its center containing only relatively benign i. e. gelatinous elements. The process of growth of the cancer occurs only at the periphery where active carcinomatous tubules and alveoli may nearly always be found although degenerative changes occasionally may be seen here before any mucus is visible. A similar condition is found in the axillary lymph nodes, the center of the node may be completely invaded and replaced by mucus while its periphery contains actively growing carcinoma. Some of the lymphatic channels of the superficial cutis may be filled with gelatin.

The mucus may be disposed in delicate strands which become filiform in the older segments of the tumor before they disintegrate completely. The presence of mucin in the tissues seems to cause no reaction in the majority of these tumors although Douthett and we independently have observed occasional lymphocytic infiltration surrounding the gelatinous locules (Fig 12). Wells injected rabbits with large quantities of pure tendon mucin almost daily for 2 to 4 months and showed absolutely no deleterious effects either locally or constitutionally. The calcareous deposits, fatty changes and occasional hyaline bodies are considered coincidental and unimportant.

The infrequent gelatinous metamorphosis of breast cancer known as the connective tissue type or myxoid carcinoma of the breast has been described best by Philip Reel as follows. Some carcinomata of the breast with abundant connective tissue framework present great quantities of mucinous intercellular substance which seems to extend widely into the tissue space of the tumor stroma. The stroma of the tumor is of homogeneous translucent mucoid material containing spindle stellate and round connective tissue cells but staining poorly with ordinary dyes. The collagen fibers are swollen and separated by fluid



770 | 771 | 772 | 773 | 774 | 775 | 776 | 7

Fig 4 Small focus of gelatinous carcinoma occurring as a secondary change in a large adenocarcinoma of the breast.

so that the cells present a water soaked appearance. While the blood supply is usually described as poor Reel states that his specimens show a rather large number of moderately dilated blood vessels, having thin and poorly developed walls. He considers the possibility that the resulting stasis indicates a disturbance that is responsible for this type of degeneration. The epithelial elements or carcinoma cells proper are not directly involved in this process.

Nature of gelatinous degeneration. The appearance of mucus in the cells of the gastrointestinal mucosa would be considered a normal physiological procedure. In which the mucus merely becomes visible by an increase



73 74 75 76 77 78 79

Fig. 3 Gelatinous degeneration of bulky cystadenocarcinoma

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Fig 6 Low power photomicrograph to show the disposition of the gelatinous locules at the periphery of the breast between normal breast tissue, *A* and fat, *B*. The epithelial cells of the tumor are seen as numerous small islands in a sea of mucus. The capsule is thin and insecure.

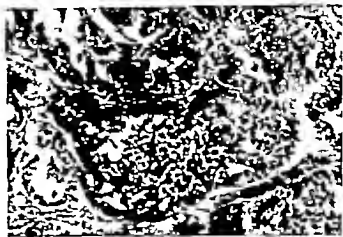


Fig 7 Early gelatinous degeneration in a bulky adenocarcinoma of the breast. Some of the degenerating cells contain mucin in small transparent droplets, while other cells are so distended by mucin that the remnants of the nuclei are barely visible.

It is our opinion that the majority of gelatinous carcinomata of the breast reveal histological evidence of the epithelial origin of the mucin. The ducts and alveoli of adenomata and carcinomata are sometimes seen to be distended with mucus (Fig 10), this finding suggests that in the beginning the process is secretory rather than degenerative. The ductal cells are compressed flatly against the basement membrane. According to Ribbert the mucus ruptures through to the connective tissue spaces where it absorbs fluid and causes edema (gelatinous imbibition). If this is true as we have every reason to believe the stroma of the cancer may be infiltrated both by the released mucus and again by the carcinoma cells producing the mucus therefore the discovery of this gelatinous substance in the connective tissue does not prove its origin from this tissue nor does the peripheral or central position of the carcinoma cells determine the genesis of the gel. The quantity of mucus may be so abundant and the number of epithelial cells so few that this relationship may be questionable but always, if diligent search be made, the association of carcinoma cells in the mucus is found. The epithelial origin of the mucus is seldom disputed in gelatinous carcinomata of the stomach and rectum where the paucity of carcinoma cells is the usual finding. The appearance of gelatin in the axillary lymph nodes containing metastatic carcinoma from the

breast is presumptive evidence of the epithelial origin unless we could assume that both the epithelial and connective tissue elements of the cancer have metastasized together, or that some chemical agent traveling with the metastasizing cells causes the stroma of the nodes to undergo mucinous changes. This would seem unlikely as the malignant connective tissue tumors of the breast seldom metastasize to axillary nodes.

In the myxomatous degeneration of breast tumors (periductal myxoma, cystosarcoma phylloides, myxoid carcinoma) the mucous tissue is really a firm resistant, immovable tissue with fixed cells and capillaries. This mucin does not extrude nor is it readily expressed from the cut surface of these tumors as it is in the true gelatinous carcinomata of the breast. Here the normal stroma of the tumor is substituted by a true mucous tissue which in turn degenerates into a dead mucous tissue (Meyer). This myxomatous connective tissue accompanying mammary cancer is genetically and microscopically similar to that found in myxoedema and certain neurogenic tumors, but quite dissimilar to the mucus occurring in true gelatinous mammary cancers.

Ewing has presented the only logical arguments in favor of the connective tissue origin of the gel, although he believes in the dual genesis. Ewing states that he has occasionally seen compact alveoli lying in broad areas of mucous stroma with no evidence of mucous

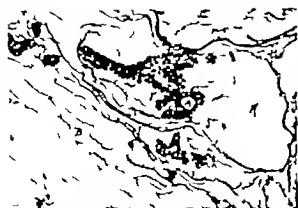


Fig. 8 The carcinoma cells seen in this illustration formerly lined the alveoli, the outline of which is seen at A. The alveolus has ruptured and the carcinoma cells and gelatinous material B as well have infiltrated the surrounding connective tissue.

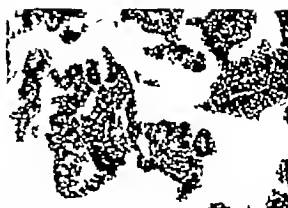


Fig. 9 Compact groups of well preserved carcinoma cells surrounded by thick mucus. The cells are of uniform size and exhibit only slight evidence of degeneration, although removed from their blood supply.

degeneration of the epithelium. Furthermore,

The usual position of the mucus outside of and surrounding compact groups of well preserved cells is not in accordance with an epithelial origin and has not been satisfactorily explained by those who maintain this origin' (Fig. 9).

As we have seen it the gelatin is first deposited around the cell nests and infiltrates peripherally to involve the connective tissue layer by layer (Fig. 11). The epithelial cells disintegrate as the mucus increases in quantity i. e. the cancer cells disintegrate in proportion to the quantity of mucus and this disappearance of the cancer cells begins in the center of the cell nests. This does not necessarily imply that the cytoplasm of these epithelial cells is uniformly converted into mucus in fact the disintegration seems to be due largely to the pressure of the secreted mucus upon the confined cells. Compact well differentiated alveoli are the last to be spared.

The fat tissue of the stroma of some of the gelatinous mammary cancers shows degenerative mucinous changes, which has led Ewing to conclude that the fat tissue may be the origin of the mucus in some of these neoplasms.

RATE OF GROWTH

The carcinomata of the breast which have only partially undergone gelatinous degeneration grow and metastasize as rapidly as their unaffected congeners. Their course is not

modified by the accident of gelatinous degeneration so long as fully viable unaltered carcinoma is present. When the entire tumor is gelatinous, especially in the type which we have classified as the purely gelatinous carcinoma, the rate of growth is slow, the course of long duration and the malignancy of low degree. The literature on this subject is replete with numerous examples of this slow course. To quote a few of the interesting observations:

Gaabe found the rate of growth of gelatinous carcinoma to be only 40 per cent as fast as for ordinary mammary cancers. He recorded the average duration of the tumor before operation as 31 months compared with 13 months for ordinary breast cancers. Twelve of Gaabe's patients were aware of the presence of the tumor for 5 or more years before admission to the hospital. Warren and Witham give the total duration from the onset of symptoms until death as 3 years for ordinary breast cancers and 8 years for gelatinous carcinomata, and an average duration before treatment of 4 years for the gelatinous carcinomata. Lange also in his summary of 75 cases showed that the total duration of the gelatinous cancers was twice as long as the average carcinoma of the breast. Four of the 20 patients surveyed by Simmonds died without operation but had the tumor from 11 to 14 years, compared with an average duration of life for ordinary mammary cancer



Fig. 10. An alveolus of the cancer is distended by mucus. The epithelium is compressed into a flat single-cell layer. The tissue spaces surrounding this alveolus are infiltrated by the gel. This finding tends to substantiate the epithelial origin of the mucus.



Fig. 11. Infiltration of stroma of cancer by gelatinous material which is always accompanied by a few carcinoma cells usually in small clusters. Epithelial cells stained by hematoxylin, connective tissue by carmine and mucus by blue thionin.

(without operation) of 27 to 32 months. The gelatinous cancer in Olivier's patient was still encapsulated after 9 years growth. In Dixon's case the tumor had its onset when patient was 30 years of age, developed an increased growth impetus at the menopause and was not removed until the patient was 81 years of age, i.e., 51 years after the known date of onset of the tumor.

Ewing attributes the slow growth to the comparative adenomatous structure of these carcinomata and to the mucoid changes in the stroma which interfere with nutrition. Ewing suggests that the long initial quiescent period is due to the fact that the gelatinous carcinomata originate through the transformation of pre-existing mammary adenomata. It does seem unlikely that a carcinoma could exist and grow so slowly as these numerous case reports would attest. The tumor is presumably benign (adenomatous) during the first part of its course. The sudden increase in size so often observed may mark the onset of gelatinous degeneration in the cancer rather than indicate an increased impetus of growth just as occurs in cystosarcoma phyllodes when it originates by myxomatous changes in the stroma of an intracanalicular fibro-adenoma. The average duration of the gelatinous cancers in our series from the recognized date of onset until patient was admitted to the hospital was 20 months although one patient asserted that it had been present for 8 years.

There have been exceptions to this conclusion that the gelatinous carcinomata are of relatively slow growth. Depres, Critchett, Lister, Stout, G. B. Schmidt and Cheate and Cutler have seen gelatinous carcinomata with an especially rapid course.

DEGREE OF MALIGNANCY

Cheate and Cutler believe that "gelatinous degeneration is one of the secondary and adventitious changes that may occur in the course of any carcinoma and does not necessarily determine the degree of malignancy of the tumor. The clinical course is dependent on the precise biological properties of the epithelial elements they contain and does not depend on either the presence or the extent of the gelatinous degeneration. Their opinion seems substantiated by the fact that 5 of their 10 gelatinous carcinomata were highly malignant anaplastic tumors recurring promptly, metastasizing widely and pursuing a rapid course but a careful scrutiny of their illustrations reveals that they have used only cases with gelatinous degeneration in parts of the tumor and not the true encapsulated wholly gelatinous carcinomata. As we previously stated in our classification the ordinary carcinomata of the breast with secondary gelatinous degeneration have the same



Fig. 2 Lymphocytic infiltration surrounding a focus of gelatinous carcinoma. The margin of the tumor shows the greatest growth activity where the cells are more abundant and the gelatinous material less homogeneous.



Fig. 3 Gelatinous carcinoma of the breast with edema and early myxomatous changes in the stroma of the tumor.

rate of growth, degree of malignancy and tendency to metastasize as other mammary cancers of the same histological type. But the wholly gelatinous multilocular encysted carcinoma of the breast is a definite clinical and pathological entity and as such is characterized by a slow rate of growth, late involvement of regional lymph nodes, and delayed recurrence, all of which indicate its low degree of malignancy.

The end results in our series of 30 cases have influenced us in our belief that the average gelatinous carcinoma of the breast has a low degree of malignancy, e.g., 57 per cent 5 year cures, compared with 41 per cent in a control group of 217 cases of ordinary mammary cancer treated by similar methods. Garbe reported 58 per cent of his patients clinically free of gelatinous cancer 3 years after treatment, which in his experience was twice as good as the results obtained for ordinary mammary cancer. One of our patients (Case 1) developed a recurrent gelatinous cancer 25 years after a radical mastectomy. The average duration of life in our fatal inoperable cases was 4.8 years which is another convincing proof of the low degree of malignancy of these tumors.

CASE 1: Gelatinous carcinoma of the breast recurrent after 25 years.

J. C., a white woman 65 years of age, entered the Memorial Hospital on April 1, 1926 for treatment of a "sore" on her nose (squamous carcinoma). A right radical mastectomy had been done for carci-

noma, 25 years before in another hospital. At the present admission, a subcutaneous, movable, oval, smooth nodule measuring 1 centimeter in diameter was found on the chest wall below the scar. This small tumor was excised on January 7, 1927, the pathological report being typical gelatinous adenocarcinoma. A postoperative radium treatment was given to the tumor site on February 4, 1927. The following factors were employed: a radon tray with a radium skin distance of 3 centimeters, a filter of a millimeter of brass, and a dose of 3,000 millicurie hours. There was no evidence of carcinoma at the last observation 6 1/2 years later (July 11, 1933).

AGE

The average age of 2,663 patients with ordinary mammary cancer who applied to the Memorial Hospital was 51 years, as compared with an average of 52 years for the 30 patients with gelatinous carcinoma of the breast. The oldest patient with any type of mammary cancer was 90 years and the youngest 17 years, while the oldest patient with gelatinous carcinoma of the breast was 85 years and the youngest 34 years of age. The diagnosis was "primary inoperable" in the former case and "primary operable" in the latter. The average age of the patients mentioned in 94 case reports from other sources was 57 years. It has frequently been asserted that gelatinous carcinomata of the breast occur in relatively older individuals (Kaufmann, Spangenthal). This difference in opinion and fact perhaps can be attributed to the number of years intervening between the average age at the recognized time of onset of the tumor and the average age of the date of application for treatment. The latter age is not always

proper in considering the age distribution of gelatinous carcinomata of the breast, as many patients have been aware of the presence of this tumor for 5, 10, and even 12 years before presenting themselves for treatment. The gelatinous degeneration of tumors is not peculiar to old age but is related entirely to phenomena intrinsic to the tumor.

SEX

Our 30 patients and the 94 patients in case reports collected from literature were women. Gaabe found 4 men in his collected group of 84 gelatinous carcinomata of the breast (5 per cent). The incidence of ordinary mammary cancers in males at the Memorial Hospital was 1.24 per cent (2.663 cases).

RACE

The distribution of these patients according to racial origin is of no particular importance. Twenty-three patients were recorded as Caucasians and 3 as negroes. The 3 negroes had primary operable gelatinous carcinomata.

HISTORY OF LACTATION

No definite conclusions can be drawn from our study of the influence of lactation on the genesis of gelatinous carcinomata of the breast. Data concerning lactation were available in 20 patients, 12 of whom had nursed one or more children. Four of the eight cancers occurring in breasts which had never lactated, were in single women.

TRAUMA

Seven patients gave a definite history of trauma to the afflicted breast while 6 others asserted that they could recall no injury. The character of the trauma varied. One patient had sustained injuries to the breast 48 years and again 4 years prior to the detection of the tumor. The average time elapsing between the trauma and the recognition of the cancer was 1½ years. No etiological importance can be ascribed to the history of trauma given by these patients for two reasons: the interval of time was usually too great and the presence of pre-existing tumors could not be ruled out in the three instances in which the tumors appeared suddenly after injury. In

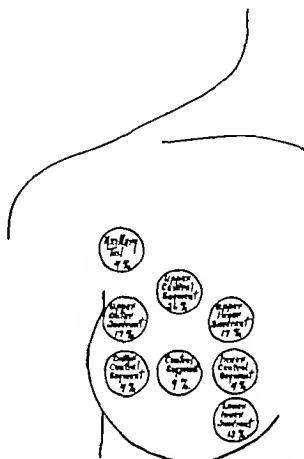


Fig. 14. Regional distribution of gelatinous carcinomata in the breast. The entire breast was involved in 1 case. The actual location of the tumor was recorded in 23 cases.

our experience a single trauma has never caused cancer of the breast. We have no reason to believe that injury to an existent breast cancer can induce gelatinous degeneration.

CLINICAL SIGNS

Halstead's sign. Halstead described 5 cases of gelatinous carcinoma of the breast in which a "surprising swish" was detected (unintentionally) on palpation of the tumor mass. The diagnosis was correctly made in advance on the fourth and fifth cases on the basis of this sign which was detected in previous cases. It is "a peculiar sensation imparted to the examining fingers when examining the gland as if something in the gland had suddenly burst, or ruptured resulting in a sudden forcing of fluid out into the intercellular spaces."

As we have stated in the classification of gelatinous carcinomata of the breast, the tumor may appear as a localized elastic, en-

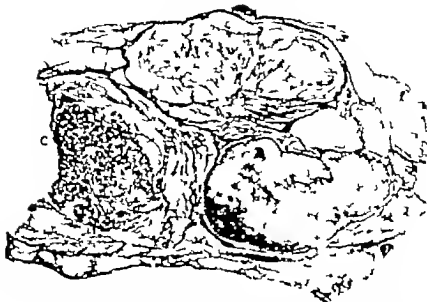


Fig. 5. Axillary lymph nodes in gelatinous carcinoma of the breast. A. Node completely replaced by gelatin. B. Node completely replaced by solid cellular metastatic carcinoma. C. Node containing both gelatin debris and degenerating carcinomatous nests.

capsulated movable mass exhibiting none of the characteristic features of malignancy or the gelatinous degeneration may develop in a pre-existent tumor modifying its course (Figs. 16 and 17). In the latter case the patient frequently relates that a slow-growing firm lump in her breast suddenly acquires an increased rate of growth and then becomes soft and fluctuant. Not all fluctuant carcinomata of the breast are of gelatinous character. The intracystic papillary cystadenocarcinomata and bulky adenocarcinomata with ischemic necrosis and cavitation may be fluctuant but the possibility of a gelatinous carcinoma must be entertained when fluctuation is elicited in an obvious cancer of the breast. We have found an analogous course and history in a series of giant intracanalicular adenomyxomata of the breast (cystosarcoma phyllodes) in which the onset of gelatinous connective tissue changes in a long-existent fibro-adenoma produces a rapidly growing large fluctuant tumor. In these giant adenomyxomata the connective tissue of the benign fibro-adenoma becomes myxomatous and the tumor usually maintains its benignancy.

Carcinomata of the breast are usually opaque to transillumination but if the gelatinous degeneration is great enough this variety of mammary cancer may be translucent. Exploratory puncture and biopsy by means of an 18 gauge aspirating needle should be done and may demonstrate the gelatinous character of the tumor.

First sign. The histories of 24 patients contained a definite statement concerning the first symptom observed by the patient. Twenty-two patients (73 per cent) gave the discovery of a lump in the breast as their first symptom and this finding parallels our experience in the survey of the first symptoms in one thousand cases of mammary carcinoma in general. Six of these patients had inoperable cancers at the time of diagnosis. A history of discharge from the nipple was obtained in none of the cases as compared with 15 per cent in the previously mentioned survey. Bleeding from the nipple was noted as the initial symptom in 4 case reports obtained from other sources; this sign would be expected as some of the gelatinous carcinomata occur in intraductal papillary carcinomata.

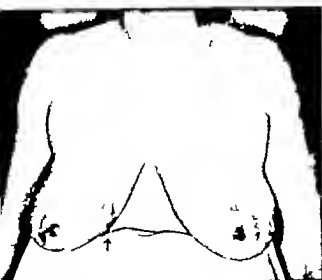


Fig 16 An encapsulated fluctuant, subcutaneous gelatinous carcinoma of the breast

The first evidence of disease in 2 patients was pain in the breast. In the first pain preceded the lump by 4 months and in the second it called the patient's attention to the mass in the breast. These 2 patients represent 6.6 per cent with pain as the first symptom as compared with 8 per cent in the one thousand breast cancers surveyed which included all types.

SIZE OF TUMOR

The size of the tumor was recorded in 14 cases of the primary operable and in 6 cases of the primary inoperable gelatinous carcinomata of the breast. Of the former group 5 were greater than 6 centimeters, 6 were 3 to 5 centimeters and 2 were less than 3 centimeters in diameter. In the latter group 4 were greater than 6 centimeters and 2 measured 5 centimeters in diameter. The largest tumor was found in the primary inoperable group measuring 15 by 15 centimeters and the smallest was in the primary operable group measuring 2 centimeters in diameter. The breast may be amputated while the tumor is small but in the average case the large size of the gelatinous carcinoma seems to be characteristic. Only 2 other varieties of mammary cancer are consistently as large, namely the diffuse duct carcinomata and the bulky adenocarcinomata. Numerous case reports recorded in the literature verify this observation, the tumors are reported as large as a 'cannon



Fig 17 A bulky encapsulated gelatinous carcinoma of the breast of slow growth rate occurring in an elderly patient

ball or "fetal head," or weighing 3 to 7 pounds (Lebert, Demarquay, Robert, Larrey). Gaabe noted the size of the tumor in 60 reported cases. 6 were as large as a child's head, 13 were the size of a man's fist and 50 per cent were the size of an apple. Ewing stated that mucoid carcinomata of the breast attain the largest dimensions of any mammary cancers. The clinical and pathological data contained in this article are one of the sources from which Ewing derived this conclusion. Cheatle and Cutler attribute the frequent large size of these tumors to an involvement of the entire duct system by the gelatinous neoplasia.

LOCATION

Gelatinous carcinomata have no specific location in the segments of the breast. Dependable data concerning the location of the tumor were available for 23 cases of this series. Five of the 28 cases were recorded only as to the side (right or left) on which they were located. The accompanying diagram (Fig 14) shows the regional tumor sites in these patients. The distribution was the same in the right and left breasts.

PAIN

In gelatinous carcinoma of the breast the unusual number of patients complaining of pain may be attributed to a sudden impetus in the rate of growth of the tumor often coincident with the gelatinous change. Sensory

disturbances varying from discomfort to severe lancinating pains in the breast often radiating down the arm or to the side of the chest were noted in 10 patients (33 1/3 per cent). Nine of these patients experienced pain before treatment was given 7 being in the primary operable group and 2 in the primary inoperable group. In the general group of breast cancers studied at the Memorial Hospital, pain has never been a frequent symptom occurring in only 8 per cent of primary operable cancers.

SKIN ADHERENCE AND NIPPLE RETRACTION

Twelve (66 per cent) of the primary operable gelatinous carcinomata of the breast were adherent to skin. These tumors were not in the purely gelatinous group. The nipple was retracted or fixed in only 24 per cent of all the cases due presumably to the fact that so many of these tumors were situated at the margins of the breast where they could not exert traction on the nipple. The localized encapsulated gelatinous carcinomata are not adherent to skin as they produce no desmoplastic changes in their neighborhood. This absence of skin dimpling and nipple retraction adds to the difficulty in the diagnosis of the benignancy or malignancy of these neoplasms. The gelatinous carcinoma ulcerates occasionally through the skin and discharges a glairy greenish mucinous slough. Three patients (42 per cent) of the primary inoperable group had fixed immobile tumors.

METASTASES

The frequency, rapidity and regional limitation of metastasis in gelatinous carcinoma of the breast agree with our classification of these tumors into 2 groups. In the groups of ordinary mammary cancers undergoing gelatinous degeneration the metastases follow the trend of the most malignant portion of the tumor. One patient with an anaplastic carcinoma of the breast in which some gelatinous changes were found died of general metastasis. In general however metastasis is not so frequent in gelatinous carcinoma of the breast and these metastases appear late in the course of the disease. Gaabe computed the average period before dissemi-

nation in these carcinomata to be 40 months, as compared with 13 months for ordinary mammary cancers. The metastases from gelatinous carcinomata of the breast are further characterized by their relatively limited distribution usually only to axillary lymph nodes, seldom to bones, lungs and liver (Monod Jayle). The metastatic lesions are not necessarily gelatinous.

Metastasis to lymph nodes. The axillary lymph nodes remain free of metastases for a long time (Binaud and Braquehay) and when involved the process is relatively inactive so that the duration of operability is longer than obtained for other mammary cancers. Gaabe estimated that the interval before involvement of the axillary lymph nodes is three times as long as for ordinary carcinomata of the breast. The axillary lymph nodes may contain solid carcinoma or a trace of gelatinous metamorphosis. In other cases the lymph nodes are entirely replaced by transparent gelatinous carcinoma (Fig. 15). Ten of our patients (55 per cent) with primary operable gelatinous cancers had metastases in the axillary lymph nodes 7 of these were verified histologically. The primary tumor in 70 per cent of these cases involved the upper outer quadrant of the breast of the axillary tail. Five patients (71 per cent) with primary inoperable gelatinous cancers had axillary metastases 1 had supraclavicular involvement. Only 1 of the patients (25 per cent) with recurrent gelatinous cancer of the breast had metastasis in the axillary and supraclavicular nodes. The number of cases is too small to compare with the ordinary recurrent carcinomata of the breast which we have found to be accompanied by metastasis in the axillary lymph nodes in 60 per cent of cases.

Metastasis to lungs and pleura. Gelatinous carcinomata of the breast are said to involve the lungs and pleura twice as frequently as the liver and abdominal lymph nodes (Gaabe, Lebert). One patient in the primary operable group developed pulmonary metastases 8 months after a radical mastectomy. Two patients (38 per cent) of the primary inoperable group had pulmonary metastases demonstrable in the roentgenograms.

Metastasis to bone Only 2 patients (6 per cent) of the entire series presented definite evidence of metastasis to bone. One young woman of 40 years developed rib metastases 5 months after a radical mastectomy. High voltage roentgen therapy was administered to the involved bones. This patient is still living and well 2½ years after the operation. The other patient developed metastases to the skull 5 months following a radical mastectomy and metastases to the pelvis, spine and femurs 3 years after operation. Both pre-operative and postoperative irradiation had been given. Death from generalized carcinomatosis took place in 3 years and 11 months after treatment was instituted.

END-RESULTS

Of the 18 patients with gelatinous carcinoma of the breast classified as "primary operable" 3 are dead 11 are living and 4 have been lost to our observation. One of these latter 4 patients was known to have been free of carcinoma for 3 years after treatment. The length of life from the onset of symptoms to death in the 3 patients who died was 6, 5½ and 2 years, an average of 4½ years. The average length of life of patients in these fatal cases after the institution of treatment was 3 years. Seven of the patients having primary operable gelatinous cancers of the breast were treated prior to July 1928. In this group 1 has been lost to further observation and 4 (57 per cent) are alive and well 5 years or more after treatment. Two of these patients (28 per cent) were treated prior to July 1926 and both are living and well 7 years after treatment. The percentage figures of the 5 year survivals are higher than the end result percentages recently computed at the Memorial Hospital for primary operable mammary cancers of all histological types, viz. 5 year survival without evidence of disease in 217 patients treated by radical mastectomy with irradiation before and after operation 41 per cent. In the 7 year survival group the latter statistics revealed 35 per cent. With so few cases in the group under present consideration it is difficult to conclude that the degree of malignancy and the prognosis following treatment are the same as for the general

group of mammary cancers. If a large group of gelatinous carcinomata of the breast could be surveyed with respect to end results, the comparison would be more significant.

In the primary inoperable group consisting of 7 patients, 4 are dead and 3 are living. The cause of death in 1 patient was cerebral hemorrhage at the age of 89 15 years after the onset of the disease and 6 years after the local mastectomy. The average duration of life after the onset of symptoms was 4 8 years. The average duration of life after the institution of therapy in these inoperable cases was 3 7 years the longest being 10 years and the shortest 6 months. Our 3 patients who are now alive were first treated 11 years, 2½ years and 2 years ago. The one who has lived 11 years without recurrence was 55 years old when first seen in November 1922. She had a movable tumor, 5 centimeters in diameter, in the upper inner quadrant of the right breast with skin adherence axillary and supraclavicular metastases. She was treated with bare radon seeds radium emanation pack low voltage X ray cycle, local mastectomy, and postoperative low voltage X ray cycle.

CASE 2 Primary inoperable gelatinous carcinoma of the breast

E. F. a white married woman, 55 years of age, was first seen at the Memorial Hospital on July 10, 1922 because of a lump in her right breast. She had been struck on the right arm and breast with a black jack 1 year prior to her application. A movable tumor, adherent to skin and measuring 5 centimeters in diameter was found in the upper central segment of the right breast. A firm enlarged lymph node was palpated in the right axilla. The carcinoma was classified as inoperable because of fullness of the right supraclavicular space. A biopsy was reported by Dr. Ewing as gelatinous carcinoma of the breast.

In the course of the next year two pre-operative low voltage X ray cycles were given to the right breast and drainage areas, followed by the implantation of glass filtered radon seeds, 9 seeds containing 15 millicuries and 14 seeds containing 17 millicuries with an interval of 3 months. Following this a local mastectomy was performed and at the same time 9 glass radon seeds containing 8 millicuries were inserted in the right axilla. The right supraclavicular space received two additional low voltage X ray treatments and two exposures to the radon pack (9,000 millicurie hours) with a filter of 2 millimeters of brass and a radium skin distance of 6 centimeters. There was no evidence of carci-

noma at the time of the last observation, June 6 1933 11 years after treatment

There were 4 patients who had recurrent gelatinous carcinomata of the breast. All are living and well. One patient had a recurrent nodule in a scar 25 years after a radical mastectomy had been performed in another institution. The treatment in February 1927 consisted in the excision of the nodule and the application of a radon tray for 3 000 millicurie hours. The patient was last seen on July 11 1933 at which time no evidence of carcinoma was present. The average duration of life of these 4 patients from the onset of the recurrence to the time of the last observation was 3 years. The time elapsing between the operative treatment of the primary tumor and application at Memorial Hospital because of recurrence averaged 18 months for 3 patients, the fourth being 25 years. The shortest period in which recurrence developed was 5 weeks.

TABLE III SUMMARY OF CASES

	Living	Dead	Lost to Observation
Primary operable	1	4	3
Primary inoperable	3	—	4
Recurrent	4	—	—
Total	18	4	7

SUMMARY

1. Gelatinous carcinomata occur in many organs of the body which normally secrete mucus. A rare and interesting type of gelatinous carcinoma is that occurring in the breast.

2. The incidence of this type of carcinoma ranges between 1 and 2 per cent of all breast cancers.

3. Gelatinous carcinoma of the breast occurs in two main forms: (a) primary gelatinous carcinoma in which the gelatinous features predominate; (b) ordinary carcinoma of the breast with secondary gelatinous degeneration. The latter type may be divided into the myxoid or mucoid carcinoma depending on whether the gelatinous changes arise by metaplasia in the connective tissue or by secretion directly from the carcinoma cells respectively.

4. In the majority of cases the epithelial cells of the tumor are the source of the gelatinous material by a secretory process. Less frequently the connective tissue assumes myxoid characteristics by a degenerative process.

5. Gelatinous carcinoma of the breast is usually slower in growth than the ordinary carcinoma. One of the reasons given for this fact is that the tumor arises on the basis of a pre-existing benign mammary adenoma in many instances.

6. No essential differences are observed in age, sex and race distribution, history of lactation and of trauma between the gelatinous carcinomata and ordinary mammary carcinomata.

7. The diagnosis of gelatinous carcinoma of the breast is made on the slow growth of the tumor, Halstead's sign, the usual signs and symptoms of ordinary breast carcinoma, and on the aspiration or punch biopsy.

8. Metastases from gelatinous carcinoma of the breast occur late in the course of the disease as compared with the usual type of mammary carcinoma, are usually confined to the axillary lymph nodes, and do not necessarily show gelatinous changes.

9. The end results of our 30 cases of gelatinous carcinoma of the breast indicate a considerably higher percentage of cures than in the usual types of carcinoma of the breast. The degree of malignancy is lower than in other carcinomata of the breast as evidenced by 57 per cent of 5 year cures as compared with 41 per cent in a control group.

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THE RELATION OF RECOVERY OF DIFFERENT SENSORY BRANCHES OF PERIPHERAL NERVES TO MOTOR RECOVERY¹

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IN a contribution (2) on the rôle of overlap in early return of some forms of sensation I stated I have never found a return of sensibility to pain when sensibility to touch has not returned except in an area of overlap. Foerster (1) believed this to be correct in the majority of instances. This seeming difference of opinion arises, I believe, in my failure properly to define my meaning. The observation was described in an article dealing with the early return of sensibility *not* the result of regeneration. The material for this study therefore dealt with severe injuries mostly confirmed at operation to be complete anatomical sections. No regeneration was present. Despite the anatomical section protopathic sensation had returned in an area lying within the border of the sensory supply of the several nerves. What I meant to say was that whenever return of sensibility had been shown to be the result of overlap and not of regeneration I had never found a return of sensibility to pain when sensibility to touch had not returned except in an area which was found by a study of residual sensibility to be one of overlap. It is well known and has likewise been observed and described by me (3) that when sensation returns as the result of regeneration, sensibility to pain alone may return within the area of the isolated supply of a nerve or touch or temperature senses alone recover in such an area.

My interest being aroused by this difference of opinion I had occasion to review some of my sensory charts. It occurred to me that one might find some correlation between the recovery of some individual sensory branches of a nerve and the return of motor function in muscles, the nerves to which were given off at levels corresponding to the sensory ones. For example, was the return of sensibility in the internal plantar nerves correlated with the return of function in any particular muscles in the foot?

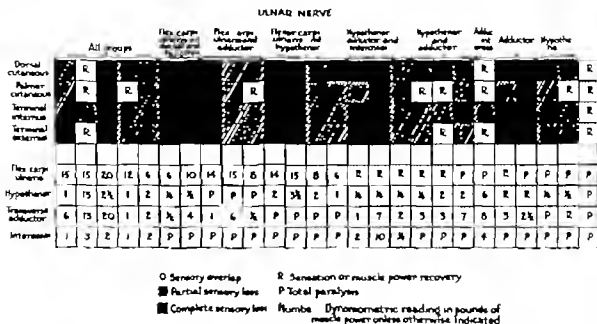
Sensory charts of recovering ulnar median radial peroneal and sciatic nerves were studied. Certain muscles supplied by these nerves were charted in terms of recovery complete or expressed in dynamometric pounds, or paralyzed and the areas supplied by individual sensory nerves plotted against them in terms of recovery (R) partial recovery (hatching) overlap (o) and complete loss of sensation (black).

ULNAR NERVE—FIGURE 1

The dorsal cutaneous branch of the ulnar nerve may be given off above the elbow although it is usually given off in the middle one third of the forearm. It supplies the dorsum of the little and ulnar half of the ring fingers and the corresponding part of the dorsum of the hand. Variations occur but this is the usual supply.

The palmar branch arises in the lower third of the forearm. It supplies the palm. The ulnar nerve divides in the palm into the superficial and deep. The latter is purely motor; the former ends by dividing into the inner and outer digital branches; the former supplies the inner side of the little finger; the latter the adjacent sides of little and ring fingers.

In 26 cases of injury above the middle third of the forearm operation had been done in 10 indicating severe lesions. Of these 4 showed no return of sensibility, 4 return of sensibility as the result of regeneration and 2 only of overlap. In the 16 remaining there was 1 with complete recovery in sensation and in this case there was no return of motion (a notable exception), 8 cases with return of sensation as the result of regeneration, 4 of complete loss of sensation and 3 of overlap. Recovery was seen in the digital branches when none had occurred in the dorsal cutaneous, but when some recovery had occurred in the latter sensation was always found to be recovering in the digital branches.



RADIAL NERVE

[illegible]

Fig. 3. Radial nerve

COMMON PERONEAL NERVE

[illegible]

Fig. 4. Common peroneal nerve.

leg below the middle third of the leg it is purely sensory. The internal terminal branch of the anterior tibial which is given off in the popliteal space, supplies the adjacent side of the first and second toes and a small area of the dorsum of the foot.

In 21 cases of peroneal nerves injured above the upper third of the leg there was evidence of some motor recovery in all of the muscles supplied by this nerve in 8 cases. Of these there was evidence of sensory regeneration in 4. In 4 other cases where the extensor pollicis had not recovered there was sensory regeneration in 3. In 2 cases in which the extensor communis digitorum and extensor hallucis were not recovering there was sensory regeneration in 1. Where in 3 cases only the peronei were recovering there was sensory regeneration in all and when all the muscles were paralyzed sensory regeneration occurred in 1 case as it did in a case of recovery only of the extensor communis digitorum. However when we analyze this sensory recovery we find in the first group recovery not only in the sural

branches but in the musculocutaneous and anterior tibial as well. In the second group whereas recovery in the sural branches occurred in 3 cases recovery in the musculocutaneous and anterior tibial occurred only in 1 case. In the third group in which some sensory regeneration was observed in 1 case it was confined to the sural branch. In the fourth group the sensory regeneration occurred only in the sural nerves and in the fifth and sixth groups sensory regeneration in the musculocutaneous or anterior tibial occurred only once. There was recovery in the musculocutaneous or anterior tibial in only 5 of 19 recovering cases. In this series in which sensory loss had been observed in the sural branches soon after injury it was noted and in the cases which on the chart have no notation no sensory loss had been present in the sural branches. It may be said therefore, that in general with less muscular recovery there is less recovery in the sural branches. But in many cases the peroneal nerve is injured before the sural branches are given off

		SCIATIC NERVE													NOT OPERATED												
		OPERATED ON TRUNK																									
Nerve	Case	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Common peroneal	1	P																									
Tibial peroneal	2		P																								
Lumbar	3	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Flexor digitorum and profundus	4	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Peroneus	5	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Tibial anterior	6	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Extensor digitorum	7	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Extensor hallucis	8	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
External saphenous	9																										
Calcaneus	10																										
Internal plantar	11																										
External plantar	12																										
Flexor hallucis	13																										
Lumbar	14																										
Anterior and posterior	15																										

Fig. 5. Sciatic nerve.

and we are then dependent upon a study of the musculocutaneous and anterior tibial nerves. We note that with recovery in all the muscles sensory recovery of these nerves occurred in only 3 of 8 cases and of the 13 remaining cases in only 2. In this regard the peroneal nerve resembles more the ulnar nerve not as might be expected the radial nerve in which there is a definite correlation between sensory regeneration and motor recovery.

In the peroneal nerve it may also be said that there is no correlation between individual sensory nerve recovery and particular muscle regeneration except that more cases showed sensory recovery in the musculocutaneous and anterior tibial where some recovery occurred in the extensor hallucis and communis digitorum muscles.

SCIATIC NERVE—FIGURE 5

The sensory supply of the peroneal nerve has already been described.

The external saphenous nerve supplies the distal part of the lower third of the leg on the outer side and the outer side of the foot and little toe. It may supply the skin of one and a half toes on the outer side of the foot and

rarely spread on to the dorsum of the foot. It is formed by the communis tibialis arising in the popliteal space and the communis fibularis from the peroneal. In such cases, in which there is failure of union the tibial branch supplies the foot, the fibular the leg. The nerve is given off above all of the motor branches to the foot and toes.

The calcaneal nerve arises from the posterior tibial in the lower third of the leg and supplies the skin of the heel and the back part of the sole.

Below the internal malleolus the posterior tibial divides into the internal and external plantar. The internal supplies sensation to the inner part of the sole to a line dividing the next to the little toe the flexor brevis digitorum adductor hallucis the flexor brevis hallucis, and the first lumbrical muscles. The external plantar supplies the inner one and a half toes and corresponding part of the sole with sensation and the rest of the small muscles of the foot.

The 46 cases of injury to the sciatic nerve may be analyzed in six groups.

1. Injured above the knee 11 cases, operated upon

	SCIATIC NERVE															Peroneal	Upper thigh	Lower thigh	Popliteal	Lower thigh				
Geometricus soles	15	15	15	15	15			15	12	15	15	15	15			R	R	15	15	20			15	15
Tibialis posticus	9	6	2	9	15			15	11	9	15	15	9			R	R	7	6	12			P	2
Lumbricals	P	P	P	2	R			1	P	R	R	R	2			R	R	P	P	P			2	P
Flexor dig longus	2	P	P	2	2			1	P	R	2	2	2			R	2	2	P	P			2	2
Peronei	5	12	6	12	15			15	13	7	R	R	15			R	R	15	R	16			P	P
Tibialis anterior	5	5	4	12	15			15	6	7	R	R	9			R	R	15	R	20			P	P
Extensor communis	2	2	2	R	R			1	1	R	R	R	2			R	R	R	2	14			P	P
Extensor hallucis	3	2	1	2	R			1	1	R	R	R	P			R	R	10	2	14			P	P
External saphenous																								
Calcaneus																								
Internal plantar																								
External plantar																								
Medial tarsal																								
Lateral tarsal																								
Anterior tibial																								
Plantar to calcaneus																								

Fig 5

2 Injured above the knee with one exception showing sensory loss in peroneal or tibial nerves 17 cases, not operated upon

3 No sensory loss 5 cases not operated upon

4 No sensory loss in the peroneal 6 cases not operated upon

5 Injured in the lower part of the thigh or popliteal space with recovery in the sensory function of the peroneal nerve 5 cases not operated upon

6 Injured in the thigh with sensory recovery in the tibial nerve 2 cases not operated upon

In the first group of cases in which operation was carried out when motor recovery has occurred only in the tibial nerve sensory recovery in the peroneal was limited to the sural branches. Of 8 cases showing sensory recovery in the peroneal nerve only 3 showed recovery in the musculocutaneous and anterior tibial similar to the lesions of peroneal nerve alone. This occurred however in the cases showing greater motor recovery. In 6 of the 11 cases all of which showed varying

degrees of motor recovery in the tibial there was sensory recovery

With the one exception when some sensory regeneration occurred in the peroneal it was also found in the tibial

In the second group of 17 cases not operated upon in 8 cases in which there was no motor recovery in the peroneal there was sensory recovery in 4 and in 3 of these it was found in the musculocutaneous or anterior tibial. When one or two muscles supplied by the peroneal had recovered, there was sensory regeneration in 2 and these only in the sural branches. When 3 or more muscles had recovered, of 5 cases there was sensory regeneration in 4 including the musculocutaneous and anterior tibial so that in sciatic nerve lesions sensory recovery occurs more frequently in these nerves than in lesions of the peroneal nerve. In 9 cases showing recovery in the musculocutaneous and anterior tibial motor recovery was noted in the extensor hallucis or communis digitorum in 6 although sensory return was seen in 3 when these muscles were paralyzed. Of the combined first and second

groups, in 10 of 18 cases, there was sensory regeneration. In cases in which complete motor paralysis of the tibial nerve may be present, marked sensory regeneration may be found and in cases in which complete recovery had taken place no sensory regeneration may be found. However when motor regeneration was more complete in the tibial sensory regeneration was found to be further advanced.

In 27 cases in which some motor recovery had taken place in the tibial nerve 18 cases showed some sensory recovery. Return of sensation in the external saphenous seemed to show some relation to recovery of the gastrocnemius.

In group 3 there was no sensory loss in either tibial or peroneal despite the incomplete motor recovery which, however, was fairly well advanced.

In group 4, sensory regeneration may be progressing in the tibial nerve and no sensory loss; found in the peroneal nerve when motor regeneration had progressed to a marked degree in both nerves.

In group 5 despite the marked motor regeneration in the tibial and peroneal nerves, there was more severe sensory loss in the tibials, although some regeneration was seen in all of them but one. In the peroneal nerve sensory recovery was found to be complete.

In the last 3 groups it is obvious that in the first the sensory nerves of both divisions of the sciatic nerve sustained a lesser injury and in the last 2 the peroneal sustained a lesser injury. In the last group the tibial nerve showed some motor recovery and complete sensory recovery and the sensory branches were probably injured to a lesser degree. This more complete recovery in tibial or peroneal or both nerves supports Stoeffel's intraneural localization at least so far as the existence of separate bundles at a certain level for sensory nerves is concerned. This observation has been noted by many and adequately discussed by Foerster. Parenthetically it may be said that Foerster's observation of the larger area of the loss of temperature sense as compared to tactile sense was confirmed by this study.

CONCLUSIONS

1. One hundred sixty seven records of sensory regeneration in recovering nerves have been analyzed to determine any possible relation between the motor recovery of certain muscles innervated by injured nerves and sensory regeneration in particular sensory cutaneous branches.

2. Sensory regeneration did not appear to be co-extensive with motor recovery of the ulnar nerve, occurring in only 50 per cent of cases. There was no specific relation between return of sensation in individual nerves and motor recovery of certain muscles.

3. When motor function was returning in injuries of the median nerve sensory regeneration could be demonstrated in 63 per cent of cases and overlap in the rest. No relation could be found between sensory return and recovery of individual muscles.

4. In most of the cases of injury of both ulnar and median nerves, sensory loss in the median was incomplete in about 88 per cent of cases, while only 23 per cent of ulnar nerves showed incomplete sensory loss.

5. Eighty per cent of recovering radial nerves showed sensory regeneration a greater proportion of cases in which regeneration was found in the extensor longus pollicis and extensor communis digitorum showed sensory regeneration than when the extensors of the wrist were recovering.

6. The more muscles recovering in peroneal nerve lesions, the more numbers of cases showed sensory regeneration of the sural nerves. The musculocutaneous and anterior tibial nerves showed sensory regeneration in only 26 per cent of all cases thus corresponding to the ulnar nerve. No correlation could be found between sensory and motor recovery.

7. In injuries of the sciatic nerve motor recovery in the peroneal nerve is associated more frequently with sensory regeneration in the musculocutaneous and anterior tibial nerves than in isolated lesions of the peroneal nerve and sensory regeneration is related somewhat to motor recovery in the extensor communis digitorum and extensor hallucis.

In some cases in which the tibial nerve was completely paralyzed marked sensory regeneration was found and in other cases in which

complete motor recovery was present no recovery of sensation was found

Complete recovery of sensation in tibial and peroneal nerves was found in cases with partial motor recovery. Complete sensory recovery of either the tibial or peroneal nerve was found when motor recovery was incomplete showing a gross intraneural localization

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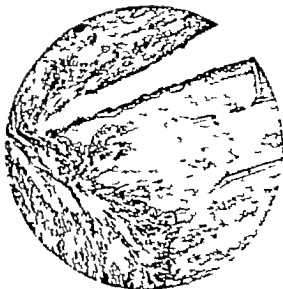
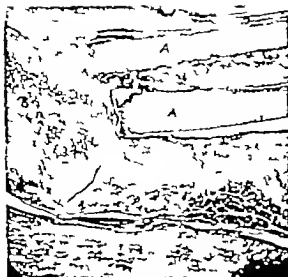


Fig 1 Boiled segment 30 days. Low power of dead graft, A new bone growth from end of radius, B higher power in circle shows surface absorption of the dead graft with no evidence of new bone growth



Fig 2 Fragmented segment, 50 days. Low power showing end of radius, A grafts, B new bone growing from them, C higher power circle showing a portion of a graft with empty lacunar spaces and some surface absorption, D but with active new bone growth arising from it, E

EXPERIMENTAL BONE REGENERATION

USING LIME SALTS AND AUTOGENOUS GRAFTS AS SOURCES OF AVAILABLE CALCIUM¹

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ATTEMPTS to perfect a means of stimulating bone growth are of interest to the clinician and research worker alike. In recent years, the use of living bone grafts has become a standard procedure in treating non union, performing fusion operations, and the like. Henderson has advocated the use of massive bone grafts in non union and has demonstrated the effectiveness of this procedure. Phemister has obtained excellent results with splint grafts. The use of autogenous bone grafts whether in the form of the massive graft, splint graft, osteoperiosteal graft or simply bone chips, has become well established.

Numerous studies have been carried out with relation to calcium and phosphorous metabolism in an effort to stimulate bone growth. Circulatory alterations have been studied (5) for the same purpose. Naturally the introduction of lime salts into the area

where stimulation of bone growth is desired has been done particularly by Murray.

Recently the exhibit (3) of Murray which was preserved at the headquarters of the American Medical Association in Chicago was inspected and a series of experiments carried out to attempt to verify his findings. Healthy dogs were chosen as the experimental animals. The composition of the lime salts which was introduced into the bone defects was $\text{Ca}_3(\text{PO}_4)_2$, 85 per cent and CaCO_3 , 15 per cent. Hastings and Zachariasen showed by X ray spectrum analysis that these two salts are in combination because only tricalcic phosphate [$\text{Ca}_3(\text{PO}_4)_2$] lines show in X ray spectrographs. The animals were operated upon under aseptic conditions. A small number of them became infected and were discarded but a reasonably large number of animals survived in good shape so that quite definite results were obtained.

The following procedures were carried out on healthy adult dogs.



Fig. 3. Radial defect filled with lime salts, 30 days. Low power showing defect filled with fibrous tissue, A muscle strands, B, an occasional bone chip left behind at operation, C marked adjacent ulnar hypertrophy. D. No evidence of the salts or new bone growth due to them.

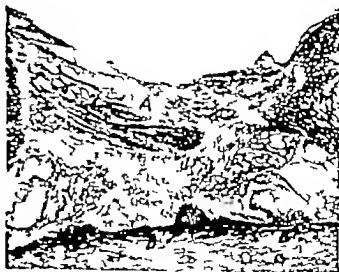


Fig. 4. Fascial bag filled with lime salts, implanted in the radial defect, 30 days. Defect filled with fibrous tissue with no evidence of new bone growth, A beginning ulnar hypertrophy. B.

¹This work was done under a grant of the Douglas South Foundation for Medical Research of the University of Chicago.

TABLE I—SUMMARY

Procedures	X-ray findings		Roentgen findings		Macroscopic findings	
	Days	Union	Callus formation	Other changes		
Exposed radial segment. H. led. muscles Replaced	30	Fibrous	None		Graft retains original density. It decreased density of adjacent radial ends. No bony union of graft to calvaria. Some new bone growth in defect, not associated with the graft, but arising from one end of the radius. Ulna fractured, healed, shows definite hypertrophy.	Graft is dead. Shows moderate surface absorption. One end of the radius shows marked surface absorption, the other end shows. Large amount of new bone formation. No new bone growth in relation to the graft. Ulna adjacent to the graft is hypertraphed (Fig. 1).
	60	Fibrous	None		Graft retains original density, with some decreased density of adjacent radial ends. No union of graft to radius. Many small areas of calcification around the graft, especially lower ends. Ulna has fractured, healed and shows definite hypertrophy.	Graft is dead and surrounded by mass of fibrous tissue and new bone growth, which latter arises from the ends of the radius, not from the graft. Marked surface absorption of the graft. It. few areas of creeping substitution. Medullary cavity of graft is filled with fibrous marrow, with absorption of the trabeculae, but no new bone growth.
Exposed radial segment, fragmented and fragments re-joined	30	Firm	Marked		Fragmented grafts are re-joined. Appear to be of same density as adjacent radius and ulna. First rate callus formation about them.	Fragmented grafts are dead but are surrounded by mass of new bone growth arising from them and the adjacent ends of the radius. A mass of creeping substitution just beginning. The amount of new bone growth is in marked contrast to the preceding sections, here the grafts are healed and there was no new bone growth from them (Fig. 2).
	60	Firm	Some large amount		Fragmented graft, but more homogeneous sections, appear since then to be the preceding specimens. Densest adjacent areas hypertrophy.	Fragmented grafts are dead and are embedded in new bone growth arising from them and the adjacent end of the radius. Process is much more advanced than in the preceding sections. Grafts are almost perfectly surrounded by creeping substitution.
Exposed radial segment filled with grafts	30	None	None		No evidence of calcification or bone growth in the defect. No union.	Acting, new bone growth from the ends of the radius. Defect is filled. It. mass of fibrous tissue. Few muscle strands and an occasional bone chip showing active bone proliferation. No evidence of the implanted calcium salt or new bone growth within bone tissue. Marked adjacent ulnar hypertrophy (Fig. 3).
	60	None	None		No evidence of calcification or bone growth in the radial defect. Ends of the radius are outside of ulnar, and show pronounced decreased density. No union.	Each of radius shows marked absorption and no new bone growth. Defect is filled with fibrous tissue and muscle strands. It. no evidence of implanted calcium salt or new bone growth. Radial ends show definite pitting, characteristic of new union.
Exposed segment re-joined in facial line containing calli	30	None	None		Defect contains no evidence of calcification, new bone growth from radial ends, particularly the proximal one. No union.	Ends of radius show definite new bone growth. Defect filled with fibrous and muscle tissue containing several small areas of calcification, as shown by deeper scans, and several small areas from which calcium may have been absorbed. No new bone growth (Fig. 4).
	60	Infected	Discontinued			
Exposed radial segment, replaced with grafts and transposed muscle		None	None		Radial defect contains no evidence of calcification or bone growth. In adjacent soft tissue approach between facial planes there are many foci of calcific material. Radial ends show no new bone growth but are smooth, rounded. No union.	New bone growth from radial ends. A few bone chips incorporated by new bone growth. Defect is filled. A fibrous and muscle tissue containing a few small areas of calcific callus, but no new bone growth (Fig. 5).
		None	None		Radial defect contains few foci of calcific material, which are few and set in soft tissue, not confined to either joint. Radial ends smooth, pointed. No union.	One radial end shows marked absorption, the other end shows new bone growth and considerable amount of creeping substitution. The defect filled with fibrous and muscle tissue, containing one area more deeply stained, suggesting remaining calcium salt. No evidence of new bone growth.

TABLE I—SUMMARY—Continued

Procedures	Necropsy findings		Roentgen findings			Microscopic findings
	Days	Union	Callus formation	Other changes	Description	
	45	None	None		No evidence of calcification or new bone growth. Fragments smooth, rounded. Ulcer hypertrophy. <i>See series</i>	One radial end shows definite new bone growth, the other marked absorption and creeping substitution. Defect is filled with fibrous tissue and contains two small bone chips showing active proliferation and transformation. No evidence of implanted calcium salts or new bone growth due to its presence
	60	None	None		No evidence of calcification or bone growth in the defect. Radial ends smooth, pointed. <i>See series</i>	Radial ends show marked absorption and pointing to new bone growth. Defect contains fibrous tissue, with no evidence of implanted salts or new bone growth
6 Excised radial segment with salts in gelatin capsule	30	Infected	Discarded			
	60	None	None		Large area of calcification in oper. area defect, with rounding off of adjacent ends and ulnar hypertrophy. <i>See series</i>	Marked new bone growth from the radial ends, with areas of absorption and creeping substitution. Defect filled with fibrous tissue containing no evidence of implanted calcium salts or new bone growth
7 Excised carpal bone replaced with salts	30			N. evidence of new bone regeneration	Defect in carpal due to removal of bone. No evidence of calcification or bone growth. Cartilage spaces thin. <i>Arthritis</i>	Carpal bones are alive, covered with live cartilage which shows occasional defect with invasion of cartilage and subchondral bone by fibrous tissue, evidence of arthritis. No evidence of implanted calcium salts or bone regeneration. Many of the marrow spaces contain very large bacilliform bodies, mostly in short chains and clumps, particularly packing the blood vessels (Fig. 6)
	60			N. evidence of new bone regeneration	Demineralization of carpal and adjacent ends of metacarpal. Cartilage spaces thin. N. evidence of calcification or bone growth in the operative defect. <i>Arthritis</i>	Marked degeneration of carpal cartilage due to fibrous tissue overgrowth. Marked arthritis. A few small deeply staining areas are seen in the fibrous tissue, suggestive of remaining implanted calcium
8 Excised carpal bone replaced with fascial bag containing salts	30			N. evidence of new bone regeneration	Small area of calcification resembling bone in the operative defect that shows definite increase in size in X-rays made 15 days apart. Cartilage spaces thin. <i>Arthritis</i>	Marked cartilage erosion by fibrous tissue, arthritis. No evidence of implanted calcium salts or new bone regeneration (Fig. 7)
	60			N. evidence of new bone regeneration	Marked rarefaction of all carpal and metacarpal bones, loss of cartilage spaces. No evidence of calcification of bone growth. <i>Arthritis</i>	Evidence of gross infection. Discarded
9 Excised astragalus, replaced by salts	30			N. evidence of new bone regeneration	One small area of calcification resembling bone in the operative defect. Marked loss of cartilage from lower end of tibia. <i>Arthritis</i>	Marked evidence of arthritis, with no evidence of calcification or new bone regeneration
	60			N. evidence of new bone regeneration	Marked rarefaction and destruction of bone of ankle joint region. N. evidence of calcification in operative defect	Infected. Discarded
Excised astragalus replaced by fascial bag containing salts	7			No evidence of new bone regeneration	N. evidence of calcification or bone regeneration in the operative defect	Infected. Discarded
	60			No evidence of new bone regeneration	Marked rarefaction of all bony components of ankle joint. No evidence of calcification or bone regeneration. <i>Arthritis</i>	Marked arthritis of tarsal bones, with the operative defect filled with fibrous tissue and necrotic debris, no evidence of implanted calcium or new bone regeneration

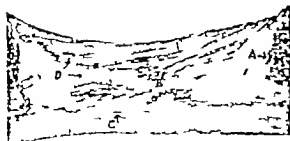


Fig 5. Radial defect filled with traumatized muscle and lime salts, 3 days. New bone growth from ends of the radius, *A*; defect filled with muscle fibers and fibrous tissue, *B*; ulnar hypertrophy, *C*; occasional area of calcification bearing no relation to new bone, *D*.

1. A segment of one radius was excised, boiled 10 minutes and replaced. The dogs were sacrificed in 30 and 60 days.

2. A segment of one radius was excised, fragmented and the fragments replaced. The dogs were sacrificed in 30 and 60 days.

3. A segment of one radius was excised and the defect filled with a mixture of lime salts consisting of 85 per cent tricalcium phosphate [$\text{Ca}_3(\text{PO}_4)_2$] and 15 per cent calcium carbonate [CaCO_3]. The dogs were sacrificed in 30 and 60 days.

4. A segment of one radius was excised; a bag made from fascia lata was filled with the

same salts and placed in the defect. The dogs were sacrificed in 30 and 60 days.

5. A segment of one radius was excised; the defect was filled with a mixture of equal amounts of the salts and bits of traumatized muscle. The dogs were sacrificed in 22, 35, 45 and 60 days.

6. A carpal bone was excised; the defect filled with the same salts, and the dogs sacrificed in 30 and 60 days.

7. A carpal bone was excised; the defect filled with a fascial bag containing salts. The dogs were sacrificed in 30 and 60 days.

8. An astragalus was excised; the defect filled with salts, and the dogs sacrificed in 30 and 60 days.

9. An astragalus was excised; the defect filled with a fascial bag containing the same salts and the animals were sacrificed in 7, 60, and 90 days.

10. A segment of one radius was excised and a gelatin capsule containing the same salts was placed in the defect. The dogs were sacrificed in 30 and 60 days.

All specimens were dissected, roentgenographed and sectioned for microscopic study.

The results of necropsy, X-ray examination and microscopic findings are tabulated with illustrations of typical findings (Table I).

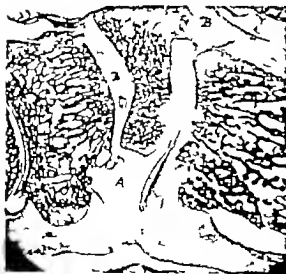


Fig 6. Carpal bone excised and defect filled with lime salts, 30 days. Defect filled with fibrous tissue containing no evidence of calcification or new bone growth, *A*; and carpal bones showing marked arthritis, *B*.

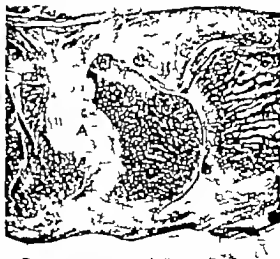


Fig 7. Carpal bone excised and defect filled with fascial bag containing lime salts, 30 days. The defect is filled with fibrous tissue containing no evidence of calcification or new bone growth, *A*; and all the carpal bones show evidence of arthritis, *B*.

SUMMARY

1 The boiled bone grafts died and when inserted into defects of the radius there was no production of new bone about or within them. The only source of new bone formation in these experiments was from the ends of the radius.

2 Small fragmented live grafts similarly used were the sources of large amounts of new bone growth in each instance. Throughout the entire series of experiments wherever a small bone chip was left behind at operation there was evidence of active bone growth from it.

3 In all cases in which lime salts were implanted in the radial defects there was failure of regeneration of the shaft.

4. The only effect of mixing traumatized muscle and lime salts in the radial defects was to create a few areas of calcification in necrotic tissue. No regeneration of the shaft took place.

5 The only constant effect of implanting lime salts in carpal and tarsal defects was the

production of a very definite proliferative arthritis. No bone was laid down in the defects.

CONCLUSIONS

1 Lime salts and boiled bone when placed into a bone defect with either traumatized muscle or fascia do not serve as a source of available calcium resulting in supersaturation of connective tissue and regeneration of missing bone.

2 Live bone chips placed in bone defects regenerate the missing bone.

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THE USE OF SMALL DOSAGES OF PITUITARY EXTRACT IN OBSTETRICS

A REVIEW OF THE LAST TWENTY TWO YEARS

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IT is now 17 years since the writer first began to use and recommend small doses of pituitary extract to induce or shorten labor (17). During this period the method has been accepted in many of the large European clinics but in this country its employment is making only very slow headway. Yet sufficient data have now been amassed to permit a critical survey of this method and to allow anyone with adequate obstetrical experience who is in possession of all the facts to judge for himself whether or not pituitary extract properly administered in small dosage is useful at the onset of labor or at the end of pregnancy to induce labor.

The idea of employing pituitary extract to induce labor was first put forward in Europe some 2 years before the beginning of the World War but the use of small doses for this purpose was my original method.

In 1912 Hager administered pituitary extract during the second labor of a woman who had lost her first child because of gestation prolonged for several weeks beyond term. By inducing labor as soon as the full period of pregnancy had been reached Hager was able to deliver a living infant without the slightest injury to mother or child. He used a dosage of 9 minims and repeated it after 7 hours.

The next year Watson in this country reported the successful induction of labor in three different cases by the administration of 10 minims of extract in repeated doses but the dosage used, though smaller than that customarily administered in the third stage of labor, was yet far larger than that which the present writer recommended in 1917.

At that time I recommended (1) the use of pituitary extract in far smaller doses than was customary (2) the use of small dosages of pituitary extract in the first stage of labor as well as later on and (3) the induction of labor at term by small dosages of pituitary extract.

The results in 64 cases—40 primiparae and 24 multiparae—were then reported. No more than 3 minims of the extract were given at any one time. After a more extended experience it was found that even smaller doses—namely 2 minims—were equally efficient so the amount was reduced thereafter to this figure.

In 79 per cent of a series of cases in which labor was induced by such 2 minim doses of pituitary extract which the present writer (16) reported in 1929 pains began after a single dose and delivery often took place without further injections.

THE AUTHOR'S METHOD

The procedure I have been employing is as follows:

- 7 a.m. castor oil, ounce
- 9 a.m. pituitary extract, minims 2
- 10 a.m. pituitary extract, minims 2
- 2 p.m. pituitary extract, minims 2
- 4 p.m. pituitary extract, minims 2

By hypodermic injection deep into thigh

The preparation of pituitary extract I have been using during all these years is obstetrical pituitrin.

When labor pains start the injections of 2 minims are continued hourly. In successful cases, the pains generally begin after the second dose. If no pains are induced, the treatment is suspended and repeated on the third day succeeding.

Never have I observed any ill effects upon mother or child from this treatment, even when as many as ten injections were given. Apparently there is no cumulative action of the drug.

USE OF MY METHOD ABROAD

The value of this method was quickly recognized abroad. In 1921 A. Calman (3) of Hamburg published an account of 34 cases in

Park's Davis product

which he had administered pituitary extract according to the plan outlined in the two papers which I published in 1917 and 1920

About the same time F J Browne who had followed the teachings of Watson presented before the Edinburgh Obstetrical Society the results of 2 years' employment of pituitary extract for the induction of labor in the venereal department of his hospital where the use of any mechanical means of inducing labor is fraught with grave danger because in the majority of the patients a purulent discharge is present. This obstetrician was most enthusiastic regarding the method the only drawback in his opinion being the lack of standardization of the drug—a defect which has now been satisfactorily remedied. When such standardization could be reached he asserted "I believe we shall be in possession of an almost ideal method for induction of labor, but even then care will be necessary because, though the drug may be standardized, it is impossible to standardize patients. There will always remain the patient who is peculiarly susceptible to its action and probably also the patient who is entirely uninfluenced."

In 1926 Scott reviewed the literature and presented the results from a questionnaire which he had sent out to American obstetricians concerning the use of pituitary extract for the induction of labor. His conclusions were that the method was "being used much more extensively than one would gather from the literature" but "there is almost unanimous opinion among those using this method that the original dosage as proposed by Dr Watson is too large."

The consideration accorded the method by the foreign medical literature was much greater than in that reviewed by Scott. A paper presented by J Eversmann in 1925 wherein he advocated the *shortening* of labor rather than attempts to abolish its pains by the use of questionable drugs aroused much discussion in medical circles. He reported favorably upon the present writer's method for inducing and shortening parturition and enumerated the advantages which the employment of small repeated doses of pituitary extract has over the more massive dosage

advocated by other writers. He claimed that every case in which he used this method had been successful.

Fram, in 1926 published a very favorable report on 75 cases while a smaller series was contributed by Hocland in 1927.

It was in 1927 that Adler also gave an account of 61 satisfactory cases. His technique varied slightly from my own.

The indications given by Adler were as follows:

1. Pregnancy prolonged beyond the natural period because it has been repeatedly observed that the child will die if retained *in utero* beyond the normal period even when it has been in good condition at the calculated termination of gestation. Also if the fetus be allowed to grow larger than normal dystocia is likely to occur when labor begins.

2. Economic considerations which are often too pressing to be disregarded. Women may enter the hospital at term after having false pains and be unable to remain beyond the expected sojourn because of poverty or the necessity for their presence in the home.

He considered either of these considerations sufficient to indicate the employment of a method which he had found harmless to both mother and child and which has proved efficient in such a large percentage of cases. The absolute requirement however is that the pregnancy must have reached term.

Hatzky in 1928 reported a series of 117 cases of delayed labor. He felt that the figures previously offered as to the success of the method of repeated small dosage had not been based upon identical conditions. Many had used it when the uterus was completely inactive or when the exact date at which confinement was due was not known and their results had been meager. On the other hand when the uterus had actually begun to contract, so that the administration of pituitary extract merely increased activity which had already been spontaneously initiated, complete success was an almost foregone conclusion. Pregnancy at term confirmed by estimating the size attained by the fetus *without any indications of the onset of labor* he considers an indication in primiparae (1) when the os is completely closed (2) when there is

entire absence of pain objectively perceptible and (3) when the membranes are intact.

This obstetrician has used a number of different preparations of pituitary extract, so that his dosage has been somewhat varied on account of lack of standardization. He commonly employs injections of 0.2 cubic centimeters at one hour intervals until a total of five injections has been given, provided that labor is not increased after the first or second injection.

Hatzky concluded that my method of inducing labor has the following advantages over the use of bags: (1) no danger of complication during the course of delivery; (2) no danger of infection because of intra-uterine manipulations; (3) greatly simplified technique; (4) no danger of premature delivery, the method succeeding only when the pregnancy has reached term; and (5) shortening of the duration of the parturition period. The only disadvantage cited is the uncertainty which Hatzky experienced in the effectiveness of the injections in producing labor pains. This may have been due in part to differences in the pituitary extract employed, since it is well known that there are wide variations in the potency of various commercial preparations.

Widera, another German writer who used the method in 44 cases in his obstetrical service at Oppeln, is very enthusiastic about this method. He had 75 per cent of complete successes, using 3 units per cubic centimeter of the Voegtlin preparation of pituitary extract at a dose the injections being given every 15 minutes until strong regular pains began. In his 44 cases, 33 labors began with satisfactory promptness, only two requiring repetition of the dosage when the first series failed to bring results. There were 11 failures.

A still later report is that of La Haye and Peters, who had tried the method in 19 cases at the Strasbourg Obstetrical Clinic. From their experience in this small series they decided that the method is most excellent if certain conditions are fulfilled:

One of the patients of La Haye and Peters showed an intoxication by the drug, this being the only case of idiosyncrasy to pituitary extract which I have heard of during 17

years' experience with the method. When she had been given 9 small injections, this woman developed clonic spasms of the diaphragm resembling hiccough which seemed to have no relation to the uterine contractions. The injections were stopped but when labor pains ceased were renewed once more after an interval of an hour and a half. After the seventh injection of the second series the spasms recurred but the labor pains were rhythmic and strong and delivery was promptly accomplished. The diagnosis of drug idiosyncrasy was confirmed by eye signs, which included the development of a transient amaurosis, a pronounced myosis with disturbance of accommodation, and feeble response to light. Tendon and cutaneous reflexes remained normal. Delivery was accomplished shortly before midnight but the hiccough continued for the remainder of the night. The following day, however, it had quite disappeared and no return of the trouble occurred.

The latest reports are those of Dueckelmann made in 1931 and of Hellendall which came out in March 1932. Their favorable results demonstrate that the popularity of the method continues to increase in European obstetrical practice.

THE PROPER DOSAGE

Despite its wide acceptance in Europe the method of inducing labor at term by small repeated doses of pituitary extract has not received the recognition in this country that it deserves. This is due to a prevalent fear that pituitary extract given prior to the expulsion period may cause violent uterine contractions and possible rupture of the uterus.

In my own experience and that of practically all European observers, no such danger exists when a dosage as small as 2 minims is employed. True Mendenhall, in 1929, accumulated from the literature 80 cases of ruptured uterus from the use of pituitary solution reported from 1913 to 1927. Yet an analysis of his series shows that, in the great majority of cases, the dosage either was not stated or was entirely too high.

Refuting Mendenhall's article in 1930, I pointed out (15) that the crux of the situation is the dosage of pituitary extract employed.

Nobody can deny the danger of injecting 1 cubic centimeter before dilatation of the cervix but abundant clinical experience proves the safety of such small doses as 0.2 cubic centimeter

SUMMARY

The preceding review of some of the reports from European obstetric services leaves no doubt of the general satisfaction which the method of inducing labor by repeated small doses of pituitary extract as described by the author in 1917 has given to a large number of clinics as well as practitioners. It is to be regretted that the method has not found a wider application in the United States. Not one of the writers who have been reviewed has noted any evil effects upon either mother or child. In not one of the complicated cases or even those in which fetal death occurred could the outcome in any way be attributed to the use of the drug. The percentage of complications is if anything lower in the cases in which pituitary extract was used to induce labor than in those in which other methods of induction were employed or even in those in which the pains occurred spontaneously.

It is to be hoped that American obstetricians will be inclined to employ the method more often as combined with the judicious administration of nitrous oxide anesthesia in the second stage. It provides a safe and efficient means of delivery which will go far to satisfy the continued demands of the modern woman that she be relieved of the age-old burden of the anguish of maternity.

The method is again fully described. After 17 years use the author's technique has not been changed and in the opinion of those who have used it it still remains the best procedure for inducing labor at term.

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ADAMANTINE TUMORS OF THE JAWS¹

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ADAMANTINE tumors have been reputed to be surgical curiosities and have not occasioned as much study as their incidence and malignant potentialities warrant. Most recent writers concur in the opinion that such growths are probably more frequent than the literature on the subject indicates. Undoubtedly many patients with such tumors have been treated without being reported and others have been operated upon with an inadequate diagnosis. This applies especially to the small unilocular lesions, which may be mistaken for radicular or dentigerous cysts. The primary purpose of this paper is to present a plan of treatment which seems rational to us, as well as to give a brief review of the clinical course and pathological aspects of the lesion.

Vorzimmer and Perla credited Guzzack with the first description of a cystic tumor of the lower jaw in 1826. Kegel (23) thinks that the history of the adamantine tumors dates from 1868 when Broca published his memorable report on a new group of tumors which he designated as odontoma. Since that time many different terms have been applied to this neoplasm. Murphy believed that Borst was the first to suggest the term adamantinoma, whereas Vorzimmer and Perla date the first full description of the tumor from Falkson's paper published in 1879. Since that time numerous designations have been applied including adamantine epithelioma, cystosarcoma, adenocarcinoma, epithelial odontoma, cystoma, cystic tumor of the jaw, multilocular cyst of the jaw, adamantine tumor, chorio-blastoma and ameloblastoma.

Classifications of tumors of dental origin have been grossly inadequate. This is due in large part to the variance in opinion as to the histogenesis of these neoplasms. Wohl suggests that they be classified either as products of inflammation or as derivatives of the tooth germ.

Several excellent resumés on the subject of adamantine tumors are offered in the litera-

ture. In 1910 Lewis collected 70 cases, including 3 of his own. In 1916 Wohl brought the total up to 82 by adding 4 original cases and including the 8 reported by New. In 1924 Murphy estimated that 100 such tumors had been collected. In 1932 Kegel cited 35 cases in which patients had been referred to the Johns Hopkins Hospital for diagnosis or treatment.

Adamantine tumors, as in other types of neoplasm, may be classified in different ways, but the usual criterion is on the basis of the growth being either unilocular or multilocular. The tumor is characteristically composed of many cystic areas, although there is a fairly large group of cases in which only one cyst is present. The diagnosis of unilocular cyst must be made with caution because in some of these growths the gross picture is one of a single large cyst whereas in reality many smaller cysts exist. Obviously this point is of considerable significance in determining the type of operation to be performed.

Another classification of these tumors is on the basis of whether they are solid or cystic. No sharp differentiation can be made on this criterion, since many intermediate cases are found in which one part of the tumor is solid and another part cystic. Whether a given tumor is solid or cystic, or whether it is composed of a single cyst or is multilocular, carries considerable prognostic import, as will be discussed later.

The size of the adamantine tumors is quite variable. It should be borne in mind that these are central expansive growths, and for this reason they are not observed early in their course and have usually attained considerable size before advice is sought. The silent central nature of this neoplasm does not make for early diagnosis. Many large tumors have been reported. Ewing speaks of an adamantinoma coming under his observation which was as large as the head of a child and weighed 15 kilograms. If these tumors made their presence known earlier their nature would undoubtedly be better understood.

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The age at which patients come under the observation of the physician or dentist is subject to wide variation. Massin has reported the earliest case on record an adamantinoma occurring in a newborn infant together with a detailed microscopic description of the tumor. The oldest case in Lewis' series occurred at the age of 75 years. The decade showing the highest incidence in Simon's series was between 20 and 30. Kegel (23) gave the age at which the tumor was first noted as between 11 and 35 years. In another paper the same author (22) stated that the time the adamantinomata usually appear is between the ages of 15 and 25 roughly the time of the second dentition. New had previously propounded the same doctrine. He noted that the average age for adamantine tumors to appear in the lower molar area was 33 years, whereas the average age for such neoplasms in the cuspid region was between 16 and 17 years of age. He was of the opinion that tooth eruption may play a part in the production of adamantinomata through the rôle of irritation. Both the cases to be reported by us occurred between the ages of 15 and 20 years. Ewing expressed the opinion that the process begins much earlier than is generally recognized but due to its prolonged nature the growth may not be noted until middle or even late life. Lewis gave the time elapsing from the time of the initial symptom or sign of the condition until removal of the mass as 8½ years. Simons concurred with an average duration of 9 years. Extremes have been reported. Eve reported a rapidly growing tumor of only 13 weeks duration the patient dying of a complication rather than directly from the tumor. Frantz and Stix reported the other extreme a patient who had been subjected to jaw resection in 1878 and who died in 1929 the tumor having recurred and been present for 51 years. Murphy stated that the semi-solid tumors evolve in from 1 to 15 years, the purely cystic in from 10 to 20 years the unilocular type averages 10 years in its development before surgical advice is sought and the multilocular develops in 14 to 15 years. Kegel (23) thought that in some cases the progress of the tumor seems to be accelerated by tooth extraction. Murphy stated that the solid type

of adamantine tumor predominates in early age and that it rarely occurs after the age of 30. Conversely the cystic type is more frequent in later life.

Kegel (23) and Graves considered the adamantinoma to be more common among the black than the white race. Westmoreland in a series of poorly described cystic tumors of the jaws noted a very marked predilection for such tumors to occur among negroes. Blair and Brown thought this neoplasm to be more common in females than males.

As to the most frequent site of this tumor opinion is unanimous. The lower molar region is by far its most frequent location. Aschoff stated that the molar and premolar areas are the most common sites of occurrence. Broders and MacCarty stated that these neoplasms are usually found near the angle of the mandible. In the series of 21 cases reported by Steensland the location was given in 20 cases. Of these 17 were in the lower jaw, 2 in the upper and in 1 case adamantine tumors occurred simultaneously in both the maxilla and mandible. In 1915 New collected 9 adamantinomata of the upper jaw, 2 of which were his own. Kegel (23) found 19 in his series of 35 to be located in the lower jaw only 2 being located anteriorly. Suker was not in accord with most writers in that he considered the most frequent site to be the upper jaw or antrum. Ewing and Murphy agreed that the solid adamantine tumors are more frequent in the upper than in the lower jaw and Ewing was of the opinion that the upper yields more of the malignant adamantinomata than does the lower jaw.

Adamantine tumors are also found in other locations than the jaws. Such growths comprise a fair percentage of the sellar and parasellar growths. Peet credits Onanoff with first noting the resemblance between these hypophyseal tumors and those of the jaws in 1892. Frazer and Alpers present 14 adamantinomata in a total of 744 tumors of that region. Peet reported 3 adamantinomata of the pituitary region and stated that the majority of such afflicted patients present the Froehlich syndrome. Carson and Hellwig reported such a suprasellar tumor and an astrocytoma in the same patient. Adamantinomata occurring in

the putative region are thought to be derived from cell rests of the embryonic hypophyseal duct. In 1931 Suker reported a case of squamous cell carcinoma of the orbit which he considered to be a metamorphosis of an adamantinoma. There is no other instance in the literature in which such a tumor originated in the orbit although some have involved the orbit by extension from the antrum. Another poorly understood adamantinoma is that which is reputed to occur in the tibia. Three such cases have been reported. Ryne thought the structure of these tumors possibly justified the diagnosis of adamantinoma. It would appear highly improbable that these tumors arise from a tooth germ. Ryne said that those of the tibia are best considered of basal-cell carcinoma of traumatic origin, having their basis not in congenital cell rests, but in the passage of a constantly frustrated reparative hyperplasia into neoplasia in a special environment of the tissue reaction. Fischer was of the opinion that the developing enamel organ of the embryo is not transferred from the oral cavity to the tibia, but rather that the growth can best be accounted for by an excessive development of the multipotent embryonic ectoderm of the leg and its differentiation in the direction of enamel formation. Baker and Hawkeley did not consider this growth to be teratomatous in origin because of the absence of other tissues, but thought that the epithelium retained its basal cell potentialities and is stimulated to growth by injury. If we accept these tibial tumors as true adamantinomata we must either alter our concept of their histogenesis, or search for a more tenable hypothesis as to the development of adamantinoma tumors of the jaws.

It is generally conceded that the adamantinomata are of epithelial origin although Broca favored the theory that they arise from the mesoderm. According to the most widely accepted theory these growths are of epithelial origin.

Three possible methods of development are propounded at the present time that adamantinomata arise from *débris épithéliaux para-dentaires* that such tumors are developed directly from the tooth germ and that they are derived directly from the alveolar epithelium.

The first hypothesis was first propounded in a classic paper by Malassez, in 1885 and is the most widely accepted theory at the present time. It was endorsed by Ewing, Bump, Suker and others. Malassez found masses of epithelial cells along the periodontal membrane from the gingival margin to the apex of the root. He considered such cell groups to be derivatives of the enamel organ and designated them as paradental epithelial *débris*. Sometimes such cell masses were observed outside the alveolodental ligament in the jaw bone. This author considered such cell aggregations to be analogous to the rich dental apparatus of some of the lower vertebrates, and thought them to be related to the supernumerary teeth of the third dentition. Simmons stated that such tumors arise from remnants of the enamel organ or from the paradental epithelial *débris*. Murphy brought out the fact that statistics show the development of these tumors is not directly related to the development of the teeth thus opposing Broca's follicular theory and upholding Malassez' rest theory. Kaufmann also ascribed the development of the adamantinoma from rests of the enamel organ. Jordan has shown that remnants of the outer cell layer of the enamel organ frequently persist and are to be found in relation to the inner margin of the bony alveolus, the wall of which is produced by intramembranous ossification in the connective tissue surrounding the embryonic dental sac.

The second theory of origin of the adamantinomata considers these tumors to arise from additional tooth germs. This theory holds that the adamantinoma arises from the neoplastic transformation of the tooth germ. Falkson has been one of the keenest exponents of this hypothesis. If we assume that these neoplasms owe their origin to neoplastic transformation of the tooth germ we might reasonably expect such tumors to be associated with faulty tooth formation in a fairly high percentage of cases. Two of the cases of New's series were associated with unerupted third molars. In one of our cases there was a supernumerary tooth in the maxilla. Curiously supernumerary symmetrically placed teeth and absence of teeth are not common

findings. If the tumor owes its origin to the neoplastic transformation of the tooth germ of a supernumerary, or even one of a permanent tooth we might reasonably expect to find a similar symmetrically placed tooth on the opposite side of the mouth, in at least an occasional case, or failure of development of the full quota of teeth in the second instance.

The third theory of origin holds that the adamantinoma arises from the mucous membrane of the oral cavity or from the mucous glands of the mouth. Broders and MacCarty found one such tumor which showed a direct connection with the epithelium of the gum through the medium of epithelial columns. This observation suggested to them that the neoplasm arises from the regenerative or basal cells of the epithelium of the mucous membrane, which would be in accord with all other types of epithelioma. Ewing has also noted such a connection but favors the theory of Malassez as to the origin of the adamantinoma. Bland Sutton subscribed to this theory of origin. Kegel (23) thought however that the adamantine epithelium invades the oral epithelium in the exceptional case which shows continuity between the tumor and the mouth, rather than being derived from it. Horsley drew attention to the fact that the clinical course of the adamantinoma is quite different from that of basal cell cancer.

Lewis quoted Bland Sutton as stating that many of the multilocular cystic tumors of the jaws are in reality endotheliomata.

Like most slowly growing tumors the early symptoms are all which accounts for the prolonged period elapsing before the patients come to surgery. Pain is not a common symptom and the one thing which brings these patients in for advice is deformity of the jaw or even of the face. Occasionally a cystic tumor ruptures into the oral cavity and discharges its content, the opening often healing spontaneously only to rupture again at a later date. Occasionally the tumor becomes infected and in that case the picture is one of an osteomyelitis. The presence of a loose tooth is sometimes the initial complaint. The history of early extraction is common. The tumor distends the tissues until only a thin bony shell is present giving a parchment like

bony capsule which crepitates on pressure. The contour may be regular or lobulated. Pathological fracture sometimes occurs. In advanced cases the tumor may impinge on adjacent structures giving rise to pressure symptoms. Phonation and mastication are sometimes embarrassed in the case of large tumors and in such lesions of the maxilla the eye may be displaced by the growth. The absence of infiltration about the tumor and the lack of fixation are important diagnostic criteria. The regional lymph glands are usually not palpable except in those cases in which the tumor is infected. Bony or fibrous trabeculation is commonly present. The cysts usually contain a thin yellow or brown fluid although it is occasionally viscid and cholesterol crystals may be present. Ewing thought the calcific particles sometimes found are probably remnants of imperfect enamel.

On roentgen examination the adamantinoma appears as a central bone expansive tumor the outline is clearly defined and there is no periosteal reaction. The tumor may be monocystic or multilocular and the so called honeycomb appearance is commonly seen.

MICROSCOPIC APPEARANCE

The epithelial constituents of the tumor are by far the most enticing for study. Several types of epithelial cell may be present. Kruse described three microscopic types of adamantinoma, based on different stages in the development of the enamel organ. Lewis considers the cylindric type to be the most characteristic cell of the adamantinoma, although the polygonal and the stellate epithelium aid in classification of such tumors. All gradations of epithelial cell from the stratified squamous to the specialized adult enameloblast are seen and often all stages between these extremes are seen in the same tumor. The epithelium may be all of one type but more commonly more than one type is present, one or the other type predominating. Broders and MacCarty describe two distinct types of cell the outer or columnar cells which they consider to be of the regenerative type and correspond to the columnar germinal or regenerative cells of the enamel organ, and the polygonal and stellate cells which are so characteristic, and

represent an advanced stage of differentiation. They also sometimes contain prickles. The peripheral columnar cells are arranged radially in a palisade layer while the stellate cells are placed more centrally. Ewing described three main types of adamantinoma. All three types are locally aggressive and he places them in the general class of carcinoma. The adenocarcinomata, or glandular tumors exhibit chiefly one structure whereas the other types show extreme and sharp variations in cell type, and the arrangement of the cells is quite diverse. In the first type the acanthoma, anastomosing cords of squamous epithelium are present in which are spine cells and pearls. In isolated areas cells showing the characteristics of the enamel organ appear. The second type is the plexiform epithelioma, showing broad convoluted columns of epithelium with no marked tendency to squamous formation. The third type is the glandular form and here the columnar enameloblasts predominate. Often the columnar cells enclose areas of reticulated cells. Numerous pearls may be surrounded by reticulated cells, and these in turn be surrounded by the columnar cells. In recurrent tumors the cells tend to lose their original identity and may eventually appear as a large round cell perivascular growth with no trace of the original epithelial origin. Aschoff described the formation of typical enamel. Wohl has observed dentine formation and Kegel spoke of both dentine and cement being found in such tumors. Fully formed teeth are sometimes observed in such cysts.

The stroma of the adamantinoma shows a wide range of variation and the proportion of epithelium to connective tissue also fluctuates widely. It may be cellular or very dense and of a hyaline nature as in the gubernaculum dentis. In the stroma of some of these tumors may sometimes be found a structure identical with that of the giant cell epulis and giant cell tumor. Portions of cement or bone may appear. Sometimes the stroma becomes exceedingly vascular. Mucoïd changes occur as well as chondrosis and calcification. Bump speaks of cases in which the stroma growth exceeds the epithelial giving the appearance of a sarcoma, and Papadimitriou presented a case for which he used the term adamantinoma

sarcomatodes, a tumor characterized by very rapid growth. He did not consider this stroma to be malignant clinically.

Thus far no definite criterion has been established for judging the malignant potentialities of a given tumor from a study of its microscopic appearance. Simmons has suggested that the degree of malignancy probably varies with the degree of differentiation of the cells. Kegel thought that no grading according to degrees of malignancy can be made on the basis of the microscopic picture, as to rapidity of growth, duration or recurrences. Ewing considered the solid tumors to be more cellular and more malignant than the cystic variety. In the case of 51 years duration reported by Frantz and Stix the sections showed an alveolar arrangement the peripheral cells being of the columnar type and arranged radially in a palisade layer with central cells of the stellate type.

DIFFERENTIAL DIAGNOSIS

The adamantinoma is a central expansive growth and must be differentiated from similar tumors occurring in the jaw bones. The differential diagnosis of intracranial adamantinomata will not be considered in this paper.

Dentigerous cysts occasionally offer considerable confusion in the differential diagnosis from adamantinomata, especially in view of the fact that dentigerous cysts often occur in the lower molar region, and because a monocular adamantinoma may be associated with an unerupted tooth. Another confusing factor is that cases have been described of dentigerous cysts with a lining of adamantine epithelium. Bloodgood in 1905 reported such a finding on Barrie's case. More recently however there is a trend to more properly consider these tumors as adamantinomata. The dentigerous cyst is lined with stratified squamous epithelium.

Radicular cysts ordinarily offer no great diagnostic problem, but there are cases in which the cyst attains large size and apparently loses its connection with the non-vital tooth from which it originated. The finding of vital teeth in the region of such a tumor obviates the diagnosis of root cyst. Thus



Fig. 1. Roentgenogram showing large unilocular cyst

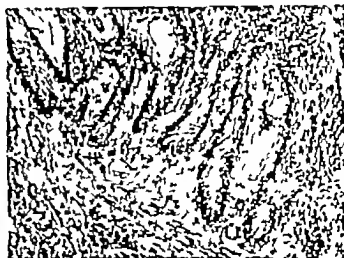


Fig. 2. Photomicrograph showing columnar cells arranged radially in palisade manner

tumor is often found in the upper lateral incisor area.

The giant cell tumor is one of the most difficult conditions to differentiate. It occurs very frequently in the lower molar area. Because of its trabeculation it may simulate an adamantinoma of the multilocular type. Giant cell tumors are much more rapid in development however and if X ray therapy be used as a diagnostic procedure it will be found that the giant cell neoplasms are much more responsive than the adamantinomata. If the duration of the tumor is unknown and if either condition is at all atypical a biopsy is often necessary to establish the true nature of the growth.

Adamantinomata of the upper jaw are often diagnosed as carcinoma of the maxillary sinus. Even on microscopic examination an undifferentiated tumor may suggest carcinoma when in reality we are dealing with an adamantinoma. The important points in the differential diagnosis are lack of the parchment like crepitation in case of carcinoma, shorter duration of the carcinoma, age in incidence of carcinoma is later than that of adamantinoma as a general rule although there are exceptions in both directions and mitotic figures are not seen in adamantine growths.

As already intimated, adamantine tumors in which the growth of the stroma is greatly out of proportion to that of the epithelial constituents, may simulate sarcoma. Here again in sarcoma as in carcinoma, parchment like crepitation is absent the sarco-

matous process is much more rapid in its evolution and mitotic figures are present.

Adamantinoma may also sometimes be confused with an osteoma or fibroma. Kegel (23) noted that some adamantine tumors may resemble polycystic osteitis fibrosa. Wohl considered endothelioma and myeloid tumor in the differential diagnosis.

Opinion is variable as to the proper treatment of these tumors. All writers agree on one point and that is that surgery is the proper therapy. X ray and radium have not received much attention in the literature as a form of treatment. Lewis noted that in one of his cases massive doses of X ray decreased the size of the tumor somewhat. In 1927 Bump stated that up to that time the X ray had not cured an adamantine epithelioma. In 6 cases Kegel (23) used the X ray or radium and noted no beneficial results from them. Simmons mentioned 1 case which showed temporary improvement following radiation. In one of his cases he used radium in repeated recurrence of the tumor and the patient died from local extension of the neoplasm to the brain.

The majority of writers favor radical treatment of these tumors advocating resection of the jaw. In 10 of the 12 cases reported by Simmons some previous form of conservative treatment had been carried out. He advocated jaw resection as the method of choice in the treatment of these tumors especially if



Fig. 3. Original roentgenogram of multilocular adamantinoma, trabeculae are well defined.



Fig. 4. Roentgenogram 1 year after operation.

the cuboidal type of epithelium is predominant or if the tumor is very large. He also felt that metastasis is more common than is generally supposed. In the series of 35 cases reported by Kegel, 19 recurred and if the cases were excluded in which radical primary resection was performed the incidence of recurrence was 79 per cent. Nevertheless, this author favored curettage followed by the thermal or chemical cautery when the tumor is monocystic and in cases in which the lesion is a solid one with an intact bony shell. He also favored subperiosteal resection in selected cases. The polycystic adamantine tumors, however, he thought are best treated by jaw resection. He noted that the recurrent tumors are more difficult to eradicate than the primary ones. Ewing noted, also, that the multilocular cysts often require sacrifice of the jaw bone for their eradication. Lewis favored wide resection since he considered these tumors practically impossible to enucleate. New likewise subscribed to resection of the jaw bone.

Ewing considered the superficial tumors and the small cysts to lend themselves readily to extirpation. Bloodgood advised conservative treatment realizing that recurrence is common.

It is generally conceded that the prognosis of the solid tumors is not as good as that of the cystic variety. Murphy favored more radical surgery in the solid and semi-solid types than in the cystic adamantinomata.

The recurrent tumors often exhibit distinct cell differences from those of the parent tumor as Ewing pointed out, the recurrences often show marked anaplasia. Malignancy often occurs in such a tumor after recurrence. It is generally conceded that metastatic involvement from adamantinomata of the jaw are unusual although Simmons considered them to be more common than generally supposed. In one of his cases there was lung metastasis and in two cases there was glandular involvement. In a fibro-epithelial tumor mentioned by Ewing metastases were observed in a cervical node and a small nodule in the lung. In another of his cases the fourth recurrence was in the cervical nodes and loose cervical tissues, and probably in the lung. Vondimer and Perla reported a case in which five operations were performed, eventually with the jaw resection with eventual metastasis to the lung. This case is peculiar in that the lung tumor was considered to be benign and not malignant and was accounted for on the basis of aspiration of adamantine tissue at the time of one of the



Fig 5 Photograph of resected section of mandible

operations. The tumor grew primarily within the lumina of the bronchial tree. Eve reported a case in 1883 in which a patient died of pneumonia following operation for an adamantinoma of the lower jaw the mass being only of 13 weeks' duration. Here the lumbar glands showed the "exact prototype of the primary growth." Kegel (12) maintained that when the adamantine tumors are left alone they never metastasize and Blood good thought that they do not metastasize in the true sense of the word but that implantation metastasis in the soft parts may follow their incomplete removal.

CASE 1 This tumor occurred in a white boy, aged 17 years. The history was negative until a few days before he sought advice, when he noticed a 'swelling' in the region of the left ramus of the mandible. He consulted his dentist who made an incision over the occlusal aspect of the mass, evacuating a large amount of thin yellow fluid. The patient was referred for surgery. The X ray (Fig 1) showed a large unilocular cyst extending forward as far as the first molar area, and posteriorly almost to the posterior aspect of the ramus. The tumor extended into the coronoid process, but the condyle was not involved. Operation was performed December 27, 1932 the tumor being thoroughly curetted and the anterior part of the internal pterygoid muscle resected, since the tumor extended backward between that muscle and the ramus of the mandible. Two weeks subsequent to operation radium treatment was instituted. To date there has been no recurrence of the tumor and the cavity has been largely replaced by new bone. The patient is symptom free except for an area of anesthesia over the distribution of the mental nerve, caused, of course, by the removal of that segment of the mandibular nerve traversing the tumor.

Microscopically the epithelium is arranged in an orderly fashion. Columnar cells arranged radially in



Fig 6 Photomicrograph showing the predominance of cuboidal type of cells

a palisade manner with the characteristic stellate cell are seen (Fig 2).

CASE 2 The second tumor occurred in a white girl 15 years of age. She had been treated elsewhere by conservative treatment (curettage) one year prior to consulting one of the authors. She complained of no symptoms at any time during the illness except the presence of a lump in the lower right molar area. Figure 3 shows the original X ray picture of the tumor revealing a multilocular adamantinoma, with well defined trabeculae.

Errors of dentition are not especially common in cases of adamantinoma. There was no anomaly of the lower molars in either of these cases, except that in this case the crown was in a transverse position, and placed posteriorly probably due to the pressure occasioned by the tumor. In this case however the X ray revealed the presence of a transversely impacted supernumerary tooth opposite the apex of the upper right second bicuspid. At the primary operation (done elsewhere) the trabeculae were well broken down and the cavities thoroughly curetted, but no electrocoagulation and chemical or thermal cauterization were employed. The tumor rapidly recurred and when seen 1 year later it entirely filled the artificially formed monocystic cavity. The X ray appearance at that time is shown in Figure 4.

Conservative operation was done a second time, on December 3, 1932 the tumor thoroughly removed by curettage, and electrocoagulation employed over the remaining tumor bearing cavity. About 2 weeks after operation radium and deep X ray therapy were instituted. There was considerable reaction to the radium. Five weeks subsequent to operation the patient developed scarlet fever but recovery was uneventful, without complication. Because of persistent adenopathy and the fact that the recurrence previously had been rapid for this type of tumor it was deemed advisable to resect the mandible together with the cervical glands. This was done March 15, 1933. Recovery was uneventful and to date there has been no evidence of recurrence. The

resected section of mandible is shown in Figure 5. Bone grafting will be done later.

The microscopic sections of this tumor show bizarre patterns. Few cylindric cells are present and the cuboidal type predominates. A few whorls are present (Fig. 6).

The factors of primary interest to the authors are the possible histogenesis of these adamantine tumors, and the type of treatment best suited for a given case.

In both our cases the full quota of permanent tooth germs are represented by well developed teeth. The only point in favor of the theory that the adamantinomatata develop directly from the tooth germ is the fact that in Case 2 there was a well developed supernumerary impacted tooth in the upper jaw. We feel that the theory advanced in the classic work of Malassez is most tenable at the present time although the other theories are not disproved.

The question of treatment is of utmost importance. In dealing with this phase of the problem we must remember that from a clinical standpoint there are several distinct types of the tumor that the microscopic features show wide variance in different tumors that the tumor is a slowly growing one that the first recurrence is not malignant as frequently as most writers would have us believe and finally that if malignancy does supervene the incidence of metastasis or even of cervical node involvement is fairly low.

The small unilocular cystic tumor offers the best chance for conservative therapy. By conservative treatment we mean the thorough curettage of the tumor mass, with adequate coagulation of the entire cavity by electro-surgery. This necessarily implies free access to the entire tumor bearing area. We feel that radium should be used after operation as a prophylactic measure realizing that these tumors are not very reactive to this form of therapy. Another type of tumor which we feel can be best treated by conservative surgery is the multilocular tumor in which the loculi are few in number and of such size as to be readily exposed to the treatment described all trabeculae being broken down. Lesions similar to that in Case 2 can be adequately treated by this method provided the cell differentiation is sufficiently far ad-

vanced as discussed below. On the contrary we feel definitely that radical surgery in the form of jaw resection together with resection of the regional lymph glands is to be advocated in those tumors which present numerous ill defined cysts, a condition in which all parts of the tumor are not easily exposed and free of access. The honeycomb tumors, with numerous small scattered loculi will come in this category regardless of the degree of differentiation of the cells.

We believe that all tumors, whether multilocular or unilocular should be treated by jaw resection if the epithelial component shows little or no differentiation of its cells. This statement may bear correction in the future and should be made with a certain degree of reservation since the correlation of the microscopic appearance of the tumor with the degree of potential malignancy is not to be gleaned from the literature in a sufficiently large series of cases to draw too definite conclusions.

We feel that the duration and size of the tumor are very definite factors to be taken into consideration in determining whether or not the therapy be conservative or radical. Obviously the rapidly growing tumors, such as those which develop within a few weeks, should be treated by jaw resection at the outset. The very large tumors, in which there is marked deformity of the jaw also require resection.

Adamantine tumors of the maxilla require more radical surgery than those of the mandible. There are two reasons for this. First, maxillary tumors are more often of the solid type than those of mandibular origin. Second, although these neoplasms probably are no more prone to metastasis than those of the lower jaw it is possible for the growth to extend by continuity into the orbit or base of the skull.

Were the recurrences malignant in a large percentage of cases, or were the percentage of metastases high, the authors would concur with those advocating radical surgery in the treatment of adamantine tumors. Since such is obviously not the case, as judged by the literature on the subject we recommend the suggestions cited.

CONCLUSIONS

1 Adamantine tumors of the jaws are undoubtedly of much greater frequency than the literature would have us believe

2 The histogenesis is best explained by the theory of paradental epithelial rests which occasionally take on the potentialities of their ancestors giving rise to the adamantinomas.

3 The explanations for the great frequency of such tumors in the lower molar region seem inadequate

4 Conservative treatment should be adopted in unilocular adamantine cysts especially if the epithelium is well differentiated and the tumor has been slow in development. The conservative treatment consists in curettage following free exposure of the cavity or cavities electrocoagulation of the tumor bearing area with possibly subsequent radium therapy

5 Radical excision of a segment of the jaw should be done in polycystic tumors when the cysts are small ill defined and not easily exposed to ready access. Radical measures should also be adopted in most adamantine tumors of the upper jaw in many tumors of the solid type and in cases showing undifferentiated epithelium. In the latter we favor radical treatment at the outset at least until sufficient cases have been reported correlating the microscopic picture with the clinical course of the lesion

6 Radium and deep X ray therapy are of very questionable value but we still use radium after operation as a prophylactic measure. It is possible that we shall discard it later but not for the present

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THE EFFECT OF MECHANICAL STIMULATION OF THE NIPPLES
ON THE OVARY AND THE SEXUAL CYCLEHANS SELYE, M.D. AND T. McKEOWN MONTREAL, CANADA
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IT is well known that the sexual cyclicity is interrupted during lactation but no satisfactory explanation of this fact has yet been offered. In a recent publication Freund discusses the problem of lactation amenorrhoea and from observations of his rich clinical material he concludes that the re-appearance of menstruation during lactation is a result of the decrease in the activity of the mammary gland. Since we have shown in our previous communications (3, 4) that the mere stimulus of suckling inhibits sexual cyclicity in the rat (even after the main milk ducts of all nipples have been cut and escape of milk has thus been made impossible) we would be inclined to think that lactation amenorrhoea in humans is also conditioned by the nervous stimulation of the nipple rather than by the secretory activity of the gland. In a more recent experimental series, we tried to establish whether the mechanical stimulation of the nipples by nursing would also inhibit the sexual cyclicity of the normally estric non lactating adult rat.

Briefly under the influence of the suckling stimulus, we observed a diestrus of about 16 days duration during which the uterus became progestational in appearance with frequent formation of placentalomata, and numerous alveoli appeared around the mammary ducts (5).

In the present paper we describe the effects of exposing normal animals to such a stimulus for a long period of time and the repetition and extension of our original observations upon the mouse.

Before proceeding with the discussion of our work we should like to draw attention to the large number of animals required in the investigation of this problem. While the suckling of an active litter is the only satisfactory method of stimulating the nipple a large quantity of experimental material must be available if litters of the right age are to be

obtained. Furthermore such litters are undernourished and therefore of little use for other work. This is why in spite of the large size of our own rat and mouse colonies, we are able to report results only on a limited number of animals. We feel, however that these results are of such a nature that one may safely base discussion on them.

Two adult female rats, seen to be normally cyclic for some time following the weaning of their own litters, were exposed to a strong suckling stimulus and the young kept alive by exchanging them on alternate days with the well nourished litter of a normally lactating mother. The young of the normal mother being transferred on these days to the experimental animal. In one of these animals this was done for a period of 10 weeks and in the other for a period of 7 weeks. The sex changes were followed by daily examination of the vaginal smears and biopsy sections were taken of the mammary glands from time to time.

With the onset of suckling the first of these animals went into a diestrus which lasted for 17 days. On the 18th day the smear showing only cornified cells indicated estrus but on the following day the animal went into a second period of diestrus which lasted 27 days. Again there was a day of estrus followed by a third diestrus of 23 days. Estrus appeared once more then a fourth diestrus, on the sixth day of which the animal was killed.

The second animal behaved similarly showing three successive periods of diestrus, separated the one from the other by a day—or in one case 2 days—of estrus. They were of 16, 16 and 15 days in length and the animal was killed at the third appearance of estrus.

The mammary glands showed in the earlier stages changes such as we described in our previous paper. The glands at the middle of the first diestrus were found to be those typical of early pregnancy—numerous alveoli

with no secretion. But 4 days before the appearance of the first estrus, secretion had begun and at estrus sections showed a fully developed and lactating gland. These results are perhaps more obvious from Figures 1, 2, and 3.

That such lactation was not subnormal was indicated by the ability of these rats to maintain normal sized litters at those periods when the glands were fully developed.

During the diestrus period, the ovaries showed a single set of large corpora lutea similar to those seen during the earlier stages of normal lactation. The peri-ovarian capsule was greatly distended with fluid (Figure 4). The hypophyses of these animals were considerably enlarged. The adrenal cortex showed a marked increase in size and a large number of cysts which were filled with eosinophilic colloid (Fig. 5).

In an attempt to repeat this work on mice we gave litters to 11 animals. Technically this offered little difficulty, for suckling occurred in almost 100 per cent of cases and no animals had to be discarded because of necrosis of the nipples. The methods of nourishing the young and of following the sex cycle and mammary gland changes were identical with those used on the rat.

We observed in all cases the cessation of estrus and development of the mammary gland as previously described.



Fig. 2 Fully developed mammary gland in a normal adult female rat on the seventy fourth day after suckling has been initiated.

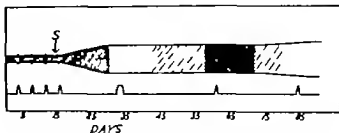


Fig. 1 Diagram showing development and secretion of the mammary gland during suckling pseudopregnancy in a rat. The upper section shows the development of the gland, the shaded parts represent the resting, the white parts the lactating condition. The line in the lower section of the diagram shows the estrus cycles.

Six of these mice were exposed to the suckling stimulus for a long time. As in the rat these animals went into successive periods of diestrus which varied in length from 13 to 21 days (Table I).

The mammary gland changes are shown in Figures 6, 7, 8, and 9. In all cases the development seen in the rat was observed to follow the beginning of suckling. Alveoli appeared around the ducts and later secretion set in. But it is interesting to note in this connection that the secretory activity of the mammary gland showed waves during these chronic experiments.

Since the changes produced by suckling so closely resemble those of the pseudopregnancy of sterile copulation, it seemed of importance to determine whether, like the latter, they were induced by a mechanism which once initiated, would continue in the absence of the original stimulus. To do this we used 20 animals and from them we removed the litters



Fig. 3 Enlargement of the nipple during suckling pseudopregnancy. To the left nipple of normal adult female rat. To the right, nipple of suckling pseudopregnant rat.



Fig. 4. Left uterine horn and ovary of suckling pseudo-pregnant rat showing great distention of the periovarian capsule.

at times between the fourth and tenth days of the diestrus.

In all cases estrus appeared between the second and fifth days following the removal of the stimulus.

Some workers have reported the formation of placentomata during lactation indicating the uterus to be progestational during this period. While we have not ourselves seen spontaneous placentomata at this time we have been able to produce them in the mouse by scratching the interior surface of the uterus with a needle and tying a thread at the site of irritation. We produced them in the same way during suckling pseudopregnancy (Fig. 10).

The fact that all these effects of suckling are due to changes in ovarian function is demonstrated by our observation that the mechanical stimulation of the nipple has no effect on either the uterus or mammary gland in the castrate.

DISCUSSION

There is a striking difference between the pseudopregnancy produced by sterile copu-



Fig. 5. Cysts in the adrenal cortex of suckling pseudo-pregnant rat.

tion and that produced by suckling. In the one case the stimulation of the cervix leads to a sequence of events—enlargement of the pituitary, formation of persistent corpora lutea, development of the mammary gland, inhibition of estrus, progestational development of the uterus with susceptibility to placentomata formation—which is initiated by a single original stimulus. In the other the continued presence of the nervous influence appears necessary. If the subsequent changes are to follow. Both bring about persistent functional corpora lutea and both result in like changes, but the modes of action seem to differ. The one may be compared to pregnancy, the other to lactation.

This is an analogy which we would like to emphasize and we feel that it is safe to do so in the light of our recent findings. All four conditions—pregnancy and copulation pseudopregnancy, lactation and suckling pseudopregnancy—are distinguished by corpus luteum function. In all the uterus is in a progestational condition. In all, estrus is inhibited. In all the mammary gland is developed. In each case the eventual appearance of estrus is inevitable. It sets in immediately at the end of normal pregnancy, it terminates the diestrus of copulation pseudopregnancy at approximately 11 days and in both lactation and the pseudopregnancy produced by suckling in the non-lactating animal the stimulus which initiated the diestrus, however effectively maintained, is

TABLE I

Animal	Periods of diestrus	
	1st	2nd
	7	7
3		7
4	9	9
5	12	
6	19	failed



Fig 6 Mammary gland of a mouse taken before beginning of suckling, showing ducts only

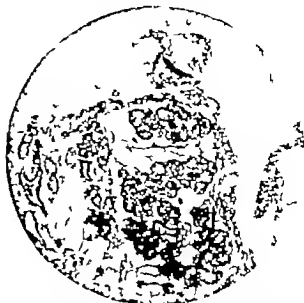


Fig 7 Mammary gland of the same mouse taken on fourteenth day of suckling pseudopregnancy. Some alveoli have formed.

without effect on its termination. But in pregnancy and in copulation pseudopregnancy these changes are all consequent to the single original stimulus, in neither lactation nor suckling pseudopregnancy is this the case.

In suckling pregnancy removal of the litter led to the return of estrus and in lactation also. In suckling pseudopregnancy the continued application of the stimulus was necessary to mammary gland development

and involution followed almost immediately on its removal, so too with lactation.

We may conclude then that the diestrus of lactation is a condition produced by the stimulus of suckling resembling in many ways that which results when the same stimulus is applied to the non lactating animal.

While copulation pseudopregnancy apparently has no parallel in human physiology suckling pseudopregnancy has since the



Fig 8 Mammary gland of the same mouse on nineteenth day of suckling pseudopregnancy. Beginning of colostrum formation.



Fig 9 Mammary gland of the same mouse on the thirty-sixth day of suckling pseudopregnancy. Full lactation.

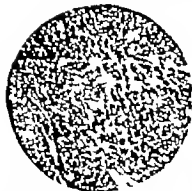


Fig. 6. Placenta to the uterus of a suckling pseudo-pregnant mouse

sexual cycles of women are inhibited during lactation. If we assume that the stimulus of nursing may produce a pseudopregnancy even in the virgin girl, then the hitherto inexplicable observations of lactation in virgins who offered their breasts to nursing infants could easily be understood. (For literature of such cases in humans see Halban.)

SUMMARY

It has been shown that both in the rat and in the mouse the mechanical irritation of the nipple produced by an actively suckling litter leads to full development of the mammary gland and to lactation. At the same time long periods of diestrus appear which are interrupted by an estrus cycle only once in 2 to 3 weeks. If the nursing litter is removed from the experimental animal during the diestrus period, normal cycles reappear within a few days.

The condition which we described is very similar to pseudopregnancy produced by sterile copulation; it differs from the latter



Fig. 11. Suckling pseudo-pregnant mouse nursing a litter

however, in that the period of diestrus is longer and that a single nervous stimulus is sufficient for the production of copulation pseudopregnancy, while the maintenance of suckling pseudopregnancy is dependent on the continuous stimulation of the nipple and is interrupted as soon as the nursing litter is removed.

We conclude from our findings that the interruption of sexual cyclicity during lactation is a result of the nervous stimulation of the nipple by nursing and not due to the secretory activity of the mammary gland.

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FUNNEL PELVIS

ITS INCIDENCE AND IMPORTANCE, AND A NEW PELVIMETER FOR OUTLET MENSURATION

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A FUNNEL pelvis is one in which the measurements of the inlet are practically normal, while one or more than one of the dimensions of the outlet are smaller than normal. In general, any measurement which exhibits a decrease of 1.5 to 2 centimeters below the average may be called contracted.

It is paradoxical that the devotees of an art which is as old as the human race should have so diligently pursued the study of contraction of the pelvic inlet, and yet, until comparatively recent times, so assiduously neglected consideration of outlet contraction or funnel pelvis.

Not until late in the eighteenth century did DuCoudray portray two cases of outlet dystocia, one representing a narrowed pubic arch and the other a much shortened distance between the symphysis pubis and the tip of the sacrum. Twenty years later the immortal Baudelocque described an outlet which measured 7.5 centimeters between the ischial tuberosities. In 1838 Busch in his textbook considered the subject of outlet contraction under its own heading and in later years the same author described dystocia in several labors complicated by this condition.

Throughout this time however no adequate system of mensuration was available and the recognition of funnel pelvis was still clouded by conjecture and theory. In 1870, Breisky described a method of measuring the distance between the lower margin of the symphysis and the tip of the sacrum—a method which has survived the test of time and is still used by many obstetricians. He also described mensuration of the hischial (transverse) diameter thus placing the entire matter upon a more scientific basis. The introduction of this procedure accomplished much for the advancement of scientific obstetrics in Europe.

In this country we became indebted to Williams for further information concerning the pelvic outlet when, in 1909 he published his excellent monograph concerning contractions of the inferior strait which he had discovered in the course of his examinations of 1,200 women. From this series of cases Williams found that funnel pelvis not only occurs more frequently than had previously been supposed but noted also that the condition is a not uncommon cause of dystocia. The same author subsequently continued his observations and later contributed more cases to his series. Thoms, working in the same clinic, added more to our knowledge of this subject when he published his statistics in 1915.

In general however, a voluminous literature devotes many pages to contractions of the superior strait, while a scanty literature concerning outlet contraction appears only reluctantly to admit the latter as an obstetrical entity.

Nevertheless dystocia at the outlet may be observed when no difficulties were present at the inlet and occasionally, when the abnormality is overlooked an operation which promised to be a simple low forceps delivery has ended with disastrous effect upon the fetal head or upon the maternal soft parts or upon both. The admonition of Barbour that "the fetal head is the best pelvimeter" holds true in so far as the superior strait is concerned for here a practical application of the dictum either manually or by a test of labor will prove or disprove the presence of disproportion. But this test, unfortunately cannot be applied to the outlet until late in labor when indeed, it may be too late if the outlet proves to be too small. And the anonymous adage "Any head which enters the pelvis can be extracted," has its rare exceptions. At least, the head cannot always be safely extracted.

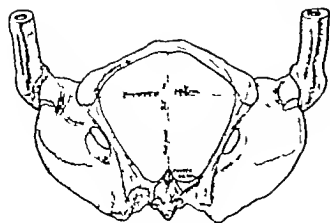


Fig. 4 The female pelvis (outlet) viewed from below

triangle possesses for its sides rigid non yielding bony barriers, while the sides of the posterior are soft yielding structures, as the levator ani and the coccygeus muscles the pelvic fasciae and to some extent the sacro-sciatic ligaments

The obstetrical diameters commonly measured here are the transverse or bischial the anterior sagittal the posterior sagittal and the anteroposterior. The anterior sagittal is the imaginary line from the midpoint of the transverse (the base) to the apex of the anterior triangle while the posterior sagittal is the measurement from the same point on the base to the apex of the posterior triangle these measurements representing the height of the anterior and posterior triangles respectively. The anteroposterior diameter because of the anatomical convexity of the pudendal surface is not the sum of the sagittal diameters but is usually considerably less than this (Figs 3 and 4). In addition to these observations valuable information concerning the breadth and conformation of the pubic arch can be elicited by means of bimanual palpation of the lateral ramus (Fig 5)

I have long been of the opinion that so called 'normal' measurements taken from dried and often shrunken pelvis are not always applicable to the living specimen with its

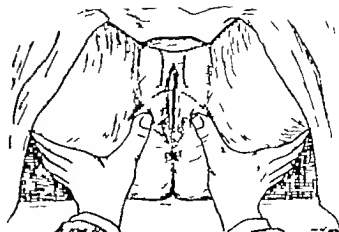


Fig. 5 Bimanual palpation of the pubic arch

superadded tissue. Accordingly I studied these diameters especially those of the outlet with the idea of effecting a comparison. In all 639 adult white women were measured of which 570 or 89.21 per cent, were patients whose pelvis were apparently normal. The results of these determinations are recorded as averages in Table I.

These results were compared with those of various other observers and to secure a grand average for each diameter are grouped in Table II. It will be seen that these averages are slightly less than those commonly used in teaching.

TABLE II — MEASUREMENTS OF NORMAL FEMALE OUTLET ACCORDING TO VARIOUS OBSERVERS

Diameter	Reported by	Cases	Cm	Grand average cm
Transverse	Williams	83	0.5	01
	Thomas	1000	0.5	
	Emmerson	217	9.70	
	Conradi	70		
	Pieri	570		
Posterior sagittal	Williams	183	7.5	7.75
	Thomas	1000	7.5	
	Emmerson	7	7.50	
	Conradi	70	8.5	
	Pieri	570	7.70	
Anteroposterior	Williams	183	5	11
	Thomas	1000	11.54	
	Allen	113	5	
	Conradi	70	11.3	
	Pieri	570	11	

TABLE I — AVERAGES OF OUTLET MEASUREMENTS IN 570 NORMAL PELVES

Diameter	Average length, cm
Transverse (bischial)	0
Posterior sagittal	7.70
Anteroposterior	11

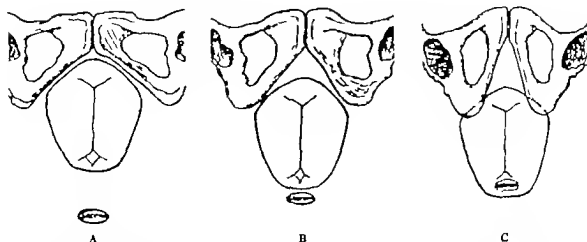


Fig. 6. Diagrammatic representation of the head in various pelves. A, Normal outlet. B, Moderate contraction. C, Absolute contraction.

For practical purposes the normal diameters of the outlet may be taken from Table II as follows:

	Cm.
Transverse diameter	11.0
Posterior sagittal	13.5
Anteroposterior	11.0

A point of great importance concerning these measurements is that forced flexion of the thighs upon the abdomen with the woman either upon her back or upon her side increases the distance between the symphysis and the tip of the sacrum from 0 to 4 centimeters. The average is 1.73 centimeters (Williams).

As to the significance of the various dimensions my experience is in accord with that of McCormick in the conclusion that there are but two practical diameters, the transverse and the posterior sagittal. The three diagrams in Figure 6 make apparent the reason for this statement and illustrate the mechanical principle involved during labor by contraction of either or both of these measurements. Diagram A represents the normal relations of the head as it comes through an outlet of normal proportions. It will be seen that most of the available area of the anterior triangle is utilized and that no dystocia exists. In B the transverse diameter is shortened, thus lessen-

ing the available space for the head in the anterior triangle *in spite of the increased length of the anterior sagittal diameter*. Consequently more of the head is forced into the posterior triangle. This depicts the reason why the second stage of labor may be unduly prolonged and illustrates the necessity for drawing the head into the posterior triangle when doing the forceps operation in these cases. It also explains the frequency of deep perineal injury which may result here from bungling attempts at delivery. The value of episiotomy in such cases to avoid serious damage to the soft parts is obvious. Diagram C represents the condition of absolute contraction of the outlet which fortunately is rarely encountered.

Of the total number of pelves (639) measured in this series 69 or 10.79 per cent, pre-

TABLE III—FREQUENCY OF PELVIC ABNORMALITY IN 639 CASES

White patients	Number	Percentage of relative incidence
Type of abnormality		
Typical funnel	26	40.31
Generally contracted (funnel-shaped)	17	24.64
Generally contracted funnel	3	4.55
Flat	20	29.95
Karyole		4.5
Total abnormalities	69	10.79

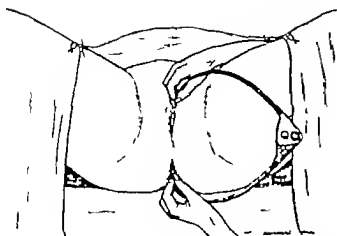


Fig. 7 Measuring the anteroposterior diameter Bresky's method

sented some pelvic abnormality as classified in Table III which shows a relative incidence of funnel pelvis of 40.58 per cent. The *typical* funnel pelvis signifies a pelvis in which the abnormality of the outlet contraction exists alone. The *generally contracted* funnel pelvis signifies exaggerated outlet contraction in a pelvis already generally contracted.

For purposes of comparison the statistics of Williams and Thoms concerning white women are combined in Table IV. The incidence of funnel pelvis here too is seen to be greater than that of any other pelvic anomaly (36.97 per cent).

A striking similarity between my findings and those recorded by Williams and Thoms is apparent when all pelvic abnormalities are grouped under three subdivisions namely (1)

TABLE IV—WILLIAMS AND THOMS' SERIES COMBINED, SHOWING RELATIVE FREQUENCY OF VARIOUS ABNORMALITIES IN 2,459 CASES

White patients		
Type of abnormality	Number	Percentage of relative incidence
Typical funnel	12	36.97
Generally contracted		33.04
Generally contracted funnel	8	5.45
Simple flat	53	15.75
Generally contracted, rachitic		3.36
Atypical	7	2.12
Flat rachitic	5	1.5
Atypical funnel	3	0.90
Total abnormalities	130	53.00

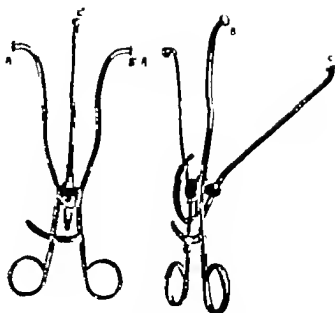


Fig. 8 The author's pelvimeter. Front and lateral views

those in which the outlet alone is contracted (typical funnel pelvis), (2) those in which the entire pelvis is contracted (generally contracted pelvis) and (3) those in which contraction of the inlet is mainly involved (practically all other types). Here again (see Table V) the incidence of funnel pelvis is seen to be higher than that of other pelvic anomalies having been found in over 4 per cent of a total of 3,098 patients examined in the several series.

The prognosis concerning the effect upon labor of various degrees of outlet contraction is not always obvious. However as a general rule if the transverse is more than 8 centimeters no difficulty need be anticipated with a head of normal size. It is frequently ob-

TABLE V—COMPARATIVE STATISTICS SHOWING THE FREQUENCY OF CONTRACTED OUTLET (FUNNEL PELVIS) IN BOTH SERIES OF CASES

Type of pelvic abnormality	Thoms and Williams series combined 2,459 cases		Piert's series 630 cases	
	Number	Percentage of incidence in the series	Number	Percentage of incidence in the series
Typical funnel	1	4.05	18	4.28
Generally contracted	730	5.70	70	3.3
All other abnormalities	78	3.5	1	5.26
Total abnormalities	530	13.40	60	1.70

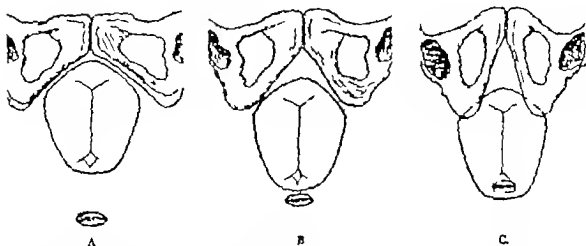


Fig. 6. Diagrammatic representation of the head in various pelvis: A, Normal outlet; B, Moderate contraction; C, Absolute contraction.

For practical purposes the normal diameters of the outlet may be taken from Table II as follows:

	Cm.
Transverse diameter	10.0
Posterior sagittal	7.5
Anteroposterior	11.0

A point of great importance concerning these measurements is that forced flexion of the thighs upon the abdomen, with the woman either upon her back or upon her side, increases the distance between the symphysis and the tip of the sacrum from 0 to 4 centimeters. The average is 1.75 centimeters (Williams).

As to the significance of the various dimensions my experience is in accord with that of McCormick in the conclusion that there are but two practical diameters, the transverse and the posterior sagittal. The three diagrams in Figure 6 make apparent the reason for this statement and illustrate the mechanical principle involved during labor by contraction of either or both of these measurements. Diagram A represents the normal relations of the head as it comes through an outlet of normal proportions. It will be seen that most of the available area of the anterior triangle is utilized and that no dystocia exists. In B the transverse diameter is shortened, thus lessen-

ing the available space for the head in the anterior triangle, in spite of the increased length of the anterior sagittal diameter. Consequently more of the head is forced into the posterior triangle. This depicts the reason why the second stage of labor may be unduly prolonged, and illustrates the necessity for drawing the head into the posterior triangle when doing the forceps operation in these cases. It also explains the frequency of deep perineal injury which may result here from bungling attempts at delivery. The value of episiotomy in such cases to avoid serious damage to the soft parts, is obvious. Diagram C represents the condition of absolute contraction of the outlet, which fortunately is rarely encountered.

Of the total number of pelvis (639) measured in this series 69, or 10.79 per cent, pre-

TABLE III.—FREQUENCY OF PELVIC ABNORMALITY IN 639 CASES

Type of abnormality	Number	Percentage of total incidence
Typical funnel	26	40.64
Conversely contracted (unfunnel)	17	26.61
Overly contracted funnel	3	4.55
Flat	30	46.98
Mesopile	1	1.55
Total abnormality	69	107.90

earlier possessed the earmarks of serious dystocia.

The necessity, however, for a fairly accurate method of outlet pelvimetry, especially if the pubic arch is narrow is obvious. The technique which I have adopted in ascertaining the measurements of the outlet has seemed to me highly satisfactory.

In measuring the length of the anteroposterior diameter (see Fig. 7) the method of Breisky was used, subtracting 1 centimeter from the reading obtained (the thickness of the tip of the sacrum). In patients in whom external palpation did not readily disclose the location of the sacral tip the finger was inserted into the rectum and the point demarcated externally.

For measuring the transverse and posterior sagittal diameters (see Fig. 2 the triangle ABC) a new instrument (Fig. 8) was devised with the co-operation of the manufacturer.¹ This pelvimeter, in my hands has presented several advantages over various other implements which I have employed. With this instrument both diameters of the triangle ABC can be measured in one operation. No assistant is necessary. From the front the instrument resembles an ordinary calipers, the arms and the tips A' and B' , of which are so constructed as to fit snugly against the ischial tuberosities in measuring the transverse diameter. A graduated scale on the anterior surface of the instrument records this distance in centimeters. The posterior arm of the pelvimeter (Fig. 8 lateral view) is freely movable laterally and anteroposteriorly and the distance (the posterior sagittal diameter) of its tip C' , from the imaginary line (the transverse diameter) between A' and B' is recorded on a second graduated scale regardless of the position in which the instrument is held. This second scale is also located on the front of the instrument. When C' is held snugly against the tip of the sacrum (the patient's buttocks must be well over the edge of the table) with A' and B' in their respective places (Fig. 9) both the transverse and the posterior sagittal diameters can be read from the instrument at the same time. All of the points being fixed points no shifting of the pelvimeter or of the

hands is necessary during the calculation. This fact minimizes the frequency of error. In thin subjects 0.5 centimeter and in obese patients 1 centimeter is added to the reading of the transverse diameter to allow for the thickness of the soft parts, while 1 centimeter (the thickness of the sacrum) is always subtracted from the reading on the posterior sagittal scale. With a little practice the whole procedure consumes but a moment. In borderline cases I have made it a point to take the average of three readings.

While it is beyond the scope of this paper to discuss in detail the management of labor in funnel pelvis, one is constrained to mention at least the salient indications and contra-indications which arise when the condition is encountered and which more than anything else bespeak here the importance of menuration. In contraction of slight degree so simple an operation as mediolateral episiotomy alone may provide the needed additional space. This type of incision of course, avoids the rectum. With increasing degree of contraction early episiotomy and forceps extraction are indicated to avoid needless protraction of the second stage of labor. And in using the forceps the mechanics of the blades and the physiology of the posterior triangle (Fig. 6 B) should be visualized. Rupture of the symphysis as has been reported through the use of the blades as a lever is an obstetrical crime.

The aftercoming head should be delivered with forceps when moderate outlet contraction exists if indeed it should not always be thus delivered.

Once the diagnosis of funnel pelvis is established the management of certain complications of pregnancy near term, such as toxæmia, and the hemorrhages becomes considerably modified. Caesarean section in these cases offering the best prognosis. During the past years in some clinics pubiotomy found favor both because of its technical simplicity and because a permanent enlargement of the outlet is claimed for it. This procedure however is now so seldom elected that at the Johns Hopkins Hospital where Williams first taught its virtues the operation has not been performed in over a decade. The reason for

¹The Royal Instrument Company, Box 172, Syracuse, New York.

this, of course, is largely due to the greatly improved surgical technique of abdominal delivery.

As has previously been suggested absolute contraction of the outlet is comparatively rare. When encountered the only alternative to craniotomy is an abdominal delivery.

CONCLUSIONS

1. Funnel shaped pelvis of moderate degree is the most common pelvic abnormality in white women. It is present in over 4 per cent of all cases.

2. Any patient who exhibits narrowing of the pubic arch should be carefully scrutinized for the possible existence of this complication.

3. For practical purposes the average outlet measurements may be taken as follows:

Transverse	Cm
Posterior sagittal	10.0
Anteroposterior	7.5
	11.0

4. The most important measurements of the inferior strait are the transverse and the posterior sagittal diameters.

5. Careful mensuration of the outlet when any contraction exists, is of definite importance in enabling the accoucheur to formulate an opinion as to the probability of a normal or operative delivery.

6. The pelvimeter described is a simple and

accurate means of determining the two most important diameters of the outlet.

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THE STERILITY OF SURGICAL CATGUT SUTURES

WITH PARTICULAR REFERENCE TO FOREIGN MADE CATGUT

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WHILE the sterility of surgical catgut manufactured in England Germany and America has been studied by investigators in those respective countries (1, 3, 5) no reference was found in the literature of a comprehensive study ever having been made by one investigator of the sterility of catgut manufactured in all of the principal countries of the world. Therefore the scope of this research was made sufficiently broad to comprise a study of the sterility of practically all brands of foreign made catgut sutures in addition to those of American manufacture. However, in view of the importance to the surgical profession of the results of my bacteriological examinations of catgut sutures sterilized with various chemical compounds it seemed inadvisable to withhold such information until the study of all brands of sutures could be completed.

In my former paper (2) dealing with the chemical sterilization of catgut I presented the results of the bacteriological examinations of several thousand catgut sutures which had been chemically sterilized with various strengths and combinations of twenty seven different chemical compounds. In that investigation which extended over a period of 2½ years I also included a study of the sterility of 154 commercial lots comprising 1,134 catgut sutures purchased from the open market. The commercial lots embraced several American brands together with one that was imported from Germany. Based on the results of that investigation I pointed out the fallacy of so called "chemical sterilization" and emphasized the reliability and uniformity of carefully controlled heat sterilization for securing positive sterility of surgical sutures.

The present investigation which is a continuation of my research work has extended over a period of 2 years. From the open market I purchased the various brands of catgut sutures which are manufactured and sold

in England France Germany Japan and Spain, and which comprise practically all brands of catgut which are marketed as sterile sutures exclusive of those manufactured and sold in the United States of America. A total of 1,204 sutures comprising 101 lots and 24 brands was tested.

The sutures used in this investigation consisted of plain catgut, sizes 0, 1, 2, and 3, and chromic catgut, sizes 00, 0, 1, 2, 3, and 4. These commercial lots included eight brands of British four brands of French six brands of German two brands of Japanese and four brands of Spanish manufacture. One-half of each lot of sutures was first subjected to a careful chemical study in order to ascertain the details of any chemical treatment to which they might have been subjected. The remainder of the lot was then tested bacteriologically in accordance with the technique previously described (2). As in the previous study the entire suture strands—not fractional parts of them—were tested aerobically and anaerobically in tubes of sterile Novy culture medium and all culture medium tubes were incubated 15 days.

BRITISH MADE CATGUT

Manufacturer A. Repeated chemical analyses revealed the presence in these sutures of large amounts of a soluble mercury compound which was not removed by the 1 per cent sodium thiosulphate and 1 per cent sodium carbonate solution specified as a neutralizing solution in the Therapeutic Substances Regulations of 1931. This brand of catgut when tested by the standard bacteriological method (5) had always shown entire absence of bacterial growth. Upon neutralizing and removing the large amount of mercury by means of a special neutralizing solution of 10 per cent sodium thiosulphate as a preliminary step in the standard bacteriological technique as described in my previous paper (2) the su-

TABLE I.—BRITISH MADE CATGUT

Mfr	Country	Lots examined	Lots non-sterile	Pct cent of non-sterile lots	No of sutures examined
A	England		8	7.7	26
B	England	3			26
C	England	7		57.1	26
D	England	7		14	20
F	England	6		16.7	26
F	England	6			26
G	England				20
H	England				20
Totals		44	8	18.2	204

tures of 8 lots out of 12 lots examined showed an abundance of bacterial growths in the aerobic and anaerobic tubes. These growths appeared at varying intervals during the 15 day incubation period and ranged from 48 hour growths to 12 day growths. The bacteria consisted of Gram positive non sporulating aerobes and Gram negative sporulating aerobes many free spores being present. Also non-sporulating anaerobes, some being Gram negative and others Gram positive.

Manufacturer B These sutures contained no chemical other than chromium in the 20 day catgut and bacteriological tests of 3 lots showed entire absence of growth.

Manufacturer C Some iron and large amounts of mercury were found in the sutures. They were labeled Sterile Catgut Plain and "Sterile Catgut Medium-Hard" but when a sterile solution of 10 per cent sodium thiosulphate was used as a preliminary step in the bacteriological technique bacterial growths appeared in the aerobic and anaerobic tubes in 2 lots of the 7 lots tested some growths appearing as early as 48 hours and others as late as 10 days. The bacteria comprised Gram positive non-sporulating aerobes and Gram positive sporulating anaerobes with gas formation in anaerobic tubes.

Manufacturer D The sutures were labeled "Catgut Sterile Plain and Catgut Sterile 20 Day." Chemical analyses showed that iodine was present in all sutures. Bacteriological tests of these sutures by the standard method revealed the presence of Gram positive non sporulating aerobes in 1 lot of the 7 lots

examined the growths appearing in from 48 hours up to 5 days.

Manufacturer E The sutures contained a moderate amount of soluble mercury. When they were subjected to bacteriological tests by the standard method Gram positive non sporulating aerobic bacteria were found in 2 lots of the 6 lots tested some growths appearing after 48 hours incubation and others as late as the twelfth day.

Manufacturer F These sutures contained a moderate amount of soluble mercury, tested by the standard bacteriological method, 6 lots showed entire absence of growth.

Manufacturer G Chemical analyses showed a moderate amount of mercury present. No growths occurred when 2 lots of these sutures were tested by the standard bacteriological method.

Manufacturer H There was a moderate amount of mercury in these sutures. When subjected to examination by the standard bacteriological method the sutures of the 2 lots tested showed entire absence of growth.

SUMMARY Thus, out of eight different brands of British made catgut sutures examined the products of four manufacturers were found to be non sterile. Of the 44 lots comprising 504 sutures tested 13 lots showed the presence of living bacteria or 29.5 per cent of the lots were non sterile (see Table I).

FRENCH MADE CATGUT

Manufacturer I Chemical analyses showed a moderate amount of mercury present. When tested by the standard bacteriological method living bacteria consisting of Gram positive non-sporulating aerobes were found in 2 lots tested some growths appearing after 48 hours incubation, others on twelfth day.

Manufacturer J These sutures contained large amounts of iron but no other chemical. Bacteriological examination of 6 lots of these sutures by the standard method showed entire absence of growth.

Manufacturer K The sutures were found to be impregnated with a soluble mercury compound. Entire absence of bacterial growth resulted when 5 lots of this manufacturer's sutures were subjected to the standard bacteriological test.

TABLE II—FRENCH MADE CATGUT

MT:	Country	Lots examined	Lots non-sterile	Per cent of non-sterile lots	No. of sutures examined
I	France	3		100	4
J	France	6	0	0	73
K	France	5	0	0	48
L	France	2		0	24
	Totals	16		13.3	68

Manufacturer L A moderate amount of mercury in the large sizes but none in the small sizes of these sutures was found. Bacteriological tests of 2 lots by the standard method resulted in entire absence of bacterial growth.

Summary Of the four brands of French made catgut sutures examined one brand proved to be non sterile. Of the 15 lots consisting of 168 French sutures tested, 2 lots showed the presence of living bacteria, or 13.3 per cent of the lots examined were non sterile (Table II).

GERMAN MADE CATGUT

Manufacturer M Etched on the tubes of these catgut sutures were the words "Sterile Plain Catgut" and "Sterile Chromic Catgut 20 Day". Chemical analyses of the small size sutures showed the presence of iron but no mercury. When the sutures of 10 lots of this manufacturer were tested bacteriologically by the standard method bacterial growths occurred in every lot, the bacteria consisting of Gram positive non sporulating aerobes and anaerobes. Some growths appeared on the second day, some on third, some on fourth, some on fifth, and others on twelfth day.

Manufacturer N Chemical analyses failed to show any chemical in these sutures. Bacteriological tests of 2 lots by the standard method resulted in entire absence of growth.

Manufacturer O The sutures contained a moderate amount of mercury. Bacteriological tests of 2 lots by the standard method showed the presence of living bacteria in every suture both the plain and chromic varieties, on the second day of incubation. The bacteria consisted of Gram positive and Gram negative non sporulating aerobes and Gram positive sporulating anaerobes with subterminal spores and gas formation.

TABLE III—GERMAN MADE CATGUT

MT:	Country	Lots examined	Lots non-sterile	Per cent of non-sterile lots	No. of sutures examined
M	Germany	10	10	100	116
N	Germany	2	0	0	24
O	Germany	3		100	24
P	Germany	3	3	100	36
Q	Germany	3	1	33	18
R	Germany	3		100	24
	Totals	21	18	85.7	242

Manufacturer P Three lots of sutures were subjected to chemical analyses, and large quantities of copper salts were found. One lot contained 2.62 per cent, another 3 per cent, and the third lot contained 3.30 per cent copper. After aseptically removing the copper salts from the sutures by means of the special neutralizing solution of ammonium chloride and ammonium hydroxide described in my former paper (2) the standard bacteriological test was applied. These tests showed an abundance of bacterial growths in every lot of this manufacturer's sutures, the bacteria comprising Gram positive non sporulating aerobes and Gram positive sporulating anaerobes with gas formation. Some growths appeared on the second day, some on the ninth day, others on the eleventh day, and some as late as the twelfth day of incubation.

Manufacturer Q Chemical analyses revealed a moderate amount of mercury. Bacteriological tests by the standard method showed the presence on the twelfth day, of Gram positive and Gram negative non sporulating aerobes in one lot while the other lot showed entire absence of growth.

Manufacturer R The sutures contained small amounts of mercury. When bacteriological tests by the standard technique were applied the presence of Gram positive non sporulating aerobes and anaerobes was revealed in 2 lots, some bacterial growths appearing on second day others on fourth, and still others on sixth day of incubation.

Summary Of the six brands of German made catgut sutures five brands were found to be non sterile. Of the 21 lots consisting of 242 sutures tested, 18 lots showed the pres-

TABLE IV—JAPANESE MADE CATGUT

Mfr	Country	Lots examined	Lots non sterile	Per cent of non-sterile lots	No. of sutures examined
S	Japan			100	8
T	Japan			100	8
	Totals			100	16

ence of living bacteria or 85.7 per cent of the lots examined were non-sterile (Table III)

In conformity with these findings are the results of the 3 year study of the sterility of catgut by Konrich and Zensler who found that 1,450 out of 1,670 (84.3 per cent) small packages of German sutures, and 584 out of 724 (80.7 per cent) large packages of German sutures contained living bacteria. Moreover these authors state "The larger German factories predominantly employ the dried intestines of Spanish English or Argentine sheep. Bacteriological examinations by Piening of 20 specimens of dried sheep intestines from Spain England and Argentina revealed the presence of 13 different species of sporulating anaerobes, including *Clostridium welchii*, *Clostridium oedematis*, malignant *Clostridium histolyticum*, *Clostridium sporogenes*, *Clostridium bifermens*, and *Clostridium multifermens*. Moreover every one of the 20 specimens of dried sheep intestines which he examined contained sporulating anaerobes."

JAPANESE MADE CATGUT

Manufacturer S. Chemical analyses of these sutures were productive of little information other than that the sutures contained mercury in moderate amount. The bacteriological examination of one lot by the standard method showed the presence of living bacteria in every suture the growths consisting of Gram positive non sporulating aerobes and anaerobes which appeared on the second and fifth days.

Manufacturer T. The sutures contained a moderate amount of mercury. When one lot of these sutures was tested bacteriologically by the standard method the presence of living bacteria was found in every suture on the fifth day of incubation the micro-organisms consisting of Gram negative non sporulating

TABLE V—SPANISH MADE CATGUT

Mfr	Country	Lots examined	Lots non sterile	Per cent of non-sterile lots	No. of sutures examined
U	Spain	6	6	100	30
V	Spain	5			60
W	Spain	4		50	48
X	Spain		4	100	48
	Totals	9	4	63	174

aerobes and Gram positive non-sporulating anaerobes.

Summary. The two brands of Japanese made sutures proved to be non sterile. Two lots consisting of 16 sutures were tested and every one of the sutures showed the presence of living bacteria or 100 per cent of the sutures were non-sterile (see Table IV).

SPANISH MADE CATGUT

Manufacturer U. Chemical analyses showed these sutures to be impregnated with mercurochrome. When 6 lots were tested bacteriologically with 10 per cent sodium thiosulphate solution as a preliminary step in the standard technique living bacteria of the aerobic and anaerobic types were found in every lot some growths appearing on the fourth some on the seventh and others on ninth day of incubation. The bacteria were Gram positive sporulating anaerobes with free spores and gas formation.

Manufacturer V. No chemical was found in the sutures. Examination of 5 lots by the standard bacteriological method showed entire absence of bacterial growth.

Manufacturer W. These sutures contained a moderate amount of mercury. When 4 lots were tested bacteriologically by the standard method entire absence of bacterial growth resulted in 2 lots while living bacteria were found in the sutures of the other 2 lots. The bacteria consisted of Gram positive non-sporulating aerobes and anaerobes some of the growths appearing on the third day and others as late as the twelfth day of incubation.

Manufacturer X. Chemical analyses of the sutures revealed a small amount of iron in the chromic variety. When 4 lots of this manufacturer's sutures were subjected to bacterio-

TABLE VI—SUMMARY OF RESULTS

Number of brands examined	24
Number of brands found non-sterile	15
Percentage of non-sterile brands	62.5
Number of lots examined	11
Number of lots found non-sterile	47
Percentage of non-sterile lots	40.4
Total number of sutures examined	1,204

logical tests by the standard method they were found to be non-sterile. Living bacteria, consisting of Gram positive non sporulating aerobes, together with Gram positive sporulating anaerobes with free spores and gas formation were found in every lot on the second day of incubation. The tube labels, box labels and circular bore the statement "sterilized at 160 degrees" although no mention was made as to whether the temperature referred to was based on the Fahrenheit or on the Centigrade scale. The fact that living bacteria were found in every lot is conclusive evidence that the sutures had never been subjected to heat at a temperature of 160 degrees Centigrade.

Summary Of the four brands of Spanish made catgut sutures examined two brands proved to be non sterile. Of the 19 lots consisting of 274 sutures tested 12 lots were found to be non sterile or 63.1 per cent of the lots examined were non sterile (see Table V).

SUMMARY AND CONCLUSIONS

1 As indicated in Table VI 1,204 sutures comprising 101 lots of 24 different brands of surgical catgut manufactured and sold in England, France, Germany, Japan and Spain were subjected to chemical and bacteriological examination.

2 Twenty four brands of foreign made catgut sutures were examined during the course of this investigation. Of these 15 brands contained living bacteria or 62.5 per cent of the brands of foreign made catgut sutures were non sterile. These non sterile brands included the sutures of 4 British manufacturers, 1 French manufacturer, 5 German manufacturers, 2 Japanese manufacturers and 3 Spanish manufacturers.

3 Of the 101 lots comprising 1,204 sutures examined in accordance with the technique previously described (2) 47 lots contained living bacteria. In other words 46.5 per cent of the lots of sutures tested proved to be non sterile. The bacteria found in the sutures comprised Gram positive and Gram negative non sporulating aerobes and anaerobes, Gram negative sporulating aerobes, and Gram positive sporulating anaerobes with subterminal spores and gas formation.

4 The high percentage of non sterile lots of foreign made catgut sutures indicates that in their preparation, entirely inadequate heat or none whatever was used for sterilization purposes reliance having been placed upon chemical methods of sterilization.

5 On the other hand those brands of foreign made catgut sutures which for the most part showed absence of bacterial growth possessed certain physical properties characteristic of heat sterilized catgut.

6 These results therefore indicate that when catgut sutures are subjected to sterilization with chemicals or with inadequate heat or with a combination of these two methods there is always grave danger that the sutures will not prove uniformly sterile, thus leaving the matter of absolute sterility open to question.

7 A critical study of the results of the bacteriological examinations of these foreign made sutures serves to emphasize the importance of two conclusions set forth in my former paper (2): "1. The so called chemical sterilization of surgical catgut by any method yet devised is inefficient and unreliable. 2. Carefully controlled heat sterilization is the only uniformly reliable and positive method of sterilizing surgical catgut sutures."

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CLINICAL SURGERY

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OPERATION FOR PHIMOSIS

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IF one is to choose between the two usual operations for phimosis, phimotomy and circumcision, he will do well to choose a third. Phimotomy while immediately relieving the symptoms, is rather disfiguring; circumcision is also cosmetically unsatisfactory and may be followed by a series of persisting unpleasant sequelae.

There are a number of so called cosmetic operations for phimosis. These are more or less ingenious, and likewise more or less complicated and the cosmetic, as well as the functional, results are often not entirely perfect. Even with the popular Schloffer operation, which is comparatively simple and yields good cosmetic effects, one often

sees, especially at first, difficulties in drawing the prepuce back and forth although this difficulty usually soon disappears.

The operation which I would recommend is even more simple and gives faultless cosmetic and functional results. The postoperative edema subsides rapidly and even at the beginning, there are no discomforts. The procedure consists simply in making a linear incision in the outer leaf of the prepuce, and inserting a triangular flap from the inner leaf between the edges of this incision. By this means the outer fold of the foreskin is widened, the entire prepuce is shortened somewhat and its opening is materially enlarged so that pulling of the foreskin forward and backward is materially facilitated.

The operation is done as follows: (1) a vertical incision is made in the dorsal midline of the outer leaf of the prepuce, beginning at the preputial orifice and extending to the region of the corona glandis, if the foreskin is short. If the foreskin is long the incision need not be carried so far. (2) After the wound margins are separated, and the prepuce is gradually retracted and freed from the glans, a V-shaped flap is made from the inner leaf of the prepuce (Fig. 1 and 2 c a d) whose apex lies at the preputial orifice, at the anterior end of the vertical incision in the external preputial fold. The base of the flap is about at the level of the pericrural end of the incision in the external leaf. The two incisions in the inner fold of the prepuce which bound the triangular flap meet at an angle of about 70 degrees. (3) The point of the flap from the inner leaf of the foreskin, during maximal retraction of the prepuce, is united to the proximal end of the incision in the outer leaf of the prepuce with one suture (a to b, Fig. 1 2 and 3). With two small, sharp hooks the wounds are drawn out linearly and closed with continuous suture. The best material for this suture is fine catgut. The frenulum is inspected and if necessary divided transversely and the incision sutured in the long axis of the

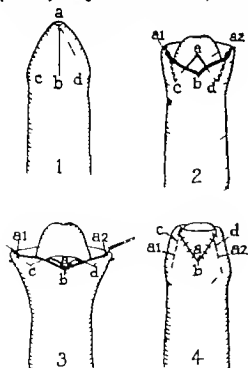


Fig. 1

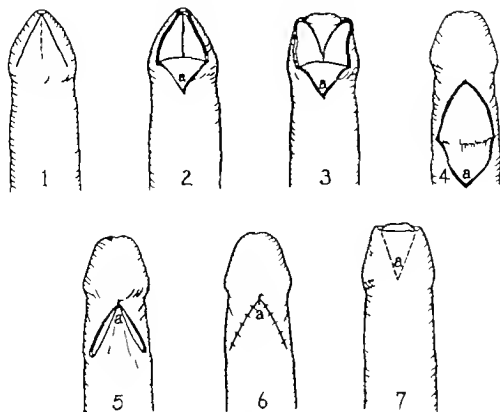


FIG. 2

penis. (4) Restoration of the prepuce if the flap is of proper length and breadth this should be easy (Fig 1 4.)

The operation is suitable for congenital as well as acquired phimosis. I usually perform it under local anaesthesia. The injection of a few cubic centimeters of novocain solution between the outer and inner leaves of the prepuce at the site of operation suffices for complete anaesthesia. Narcosis is necessary only in small children or in the presence of extensive adhesions between glans and inner leaf of foreskin.

The operation may also be done by inserting a triangular flap from the outer leaf of prepuce into a vertical incision in the inner preputial leaf (Fig 2 1 to 7). The execution of the operation in this manner is technically even easier and it is particularly recommended when there are severe adhesions between prepuce and glans. The first described procedure however insertion of a flap

from the inner fold of the prepuce into a vertical incision in the outer preputial leaf seems to give better cosmetic and functional results.

Both procedures are modifications of a method which I described 25 years ago published only in Hungarian (4). Somewhat similar techniques are reported in the German literature by Linhart and Pagenstecher. Triangular flaps of the inner and outer leaves of the prepuce are also used in the methods of Tobiaszek and Druener six flaps in the former and 4 in the latter. However these operations are much more complicated than the one described above.

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EXPLORATION OF THE COMMON DUCT IN GALL-STONE SURGERY

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IN the past 20 years the surgery of gall stones has changed from the relatively simple operation of incision and drainage of the gall bladder with the removal of stones to the more technical procedure of removing the gall bladder and stones. In the days of cholecystostomy the common duct was approached by the surgeon only at the rarest intervals and on the most positive indication. Improvements in technique and the advantages which present day methods in anesthesia give have made the exposure of the common duct a much easier procedure and, therefore, its opening and inspection a more frequent undertaking. With this increasing ease of approach to the common duct there is a growing recognition of the importance of exploration of the common duct in the course of operation for the removal of gall stones.

Relatively few studies have been made of the relationship between stones in the gall bladder and stones in the bile duct. The most comprehensive study of this type with which we are familiar was made by Curtis Crump who examined the biliary tract from 1,000 consecutive autopsies (1). In this series of 1,000 cases Crump found definite evidence of gall stones in 325 or 32.5 per cent. In these 325 patients with gall stones at autopsy, 4 per cent were found to have stones in the ducts—the hepatic, common and cystic. In a personal communication Dr. Crump informs me that if the stones in the cystic duct were omitted 21 per cent of the gall-stone cases coming to necropsy showed stones in the main bile ducts. Wilkie (quoted by Crump) found stones in the bile ducts in 18 per cent of his operative cases of gall stones. We have previously reported findings in recent years, common

duct stones in 18 per cent and over of our gall-stone operations (1, 4).

As our interest in common duct stones has increased we have explored the common duct with increasing frequency. Table I shows that in the years 1910-1926 our exploration was done in 15.5 per cent while in 1933-1934 it was done in 35 per cent. It would thus appear that of 35 to 40 per cent of the common ducts explored during the course of an operation for gall stones 17 to 21 per cent contain stones. This figure, 21 per cent, is approximately the normal percentage of stones which we should expect to find in the duct as demonstrated by the work of Crump. In view of the fact that, in our experience we have been able to demonstrate this number of stones, we believe that it might be well to summarize our conclusions as to the indications for opening the common duct when we are operating upon the gall bladder for stones, to review the technique of choledochostomy, and to discuss the management of common duct drainage with its complications and its end results.

While it is readily possible to outline the indications for the opening of the common duct and the search for stones during the course of an operation for gall stones, it is becoming more and more impressed upon us that, in every case, the common duct should at least be suspected of containing stones and that exploration should be withheld only for very positive reasons.

We explore the common duct when either the history or the physical examination is suggestive of common duct stones. Attacks of gall-stone colic followed by jaundice are so indicative of some obstruction to the common duct that the duct should always be opened. However, the absence of jaundice following attacks of pain, is no indication for failing to open the common duct as we have previously shown. Thus, in the years 1931-1932 we operated upon 46 patients with common duct stones and of this number 67 per cent gave a history of jaundice after their attacks of pain or were jaundiced at the time of operation. More important, however, is the fact that 33 per cent of these patients with common duct stones had no jaundice at the time of operation nor had they any history of jaundice following their pain in the past. A similar finding was made in the series of common duct stones, which we reported in

TABLE I—EXPLORATION OF DUCTS

Years	Total cases	Ducts explored per cent	Stones discovered and removed per cent
1910-1926		15.5	8
1927-1932	95	12	14
1928-1930		8	6
1930-1932	125	4.5	21
1931-1933	20	43	7
1933-1934		35	7.6

1930 in which 39 per cent of 74 patients with common duct stones had no history of jaundice in the past and were not jaundiced at the time of operation (1).

It is apparent then that we must rely very largely upon the operative findings to determine whether or not we shall open the common duct when removing the gall bladder for stones. If we find a small, thick walled contracted gall bladder which is the type classically associated with stones in the common duct, then we feel the common duct should be opened and investigated. If stones or thickening along the common duct can be palpated with the examining finger the common duct should be opened and explored. Any thickening should be considered suspicious and exploration undertaken. It is readily recognized that a stone of small diameter lying in the ampulla of Vater may be extremely difficult to palpate through the layers of the pancreas, the duodenum, and mesenteric tissues overlying the ampulla. Definite thickening and induration in the head of the pancreas, therefore, should lead us to investigate the common duct.

A gall bladder which contains numerous very small stones of a type which could easily pass through the cystic duct may have had stones pass into the common duct and therefore we open the common duct in such a case. The presence of one or two tiny stones, which can be palpated in the valves of the cystic duct, is strongly suggestive of possible stones in the common duct, and we have been impressed with the frequency with which stones are found in the common duct in this circumstance. We have noted that stones may be overlooked in the stump of the cystic duct, which is left in the dissection for cholecystectomy. We have had this experience and have reported (2) in several patients the finding of tiny stones embedded in the valves of the cystic duct which, following cholecystectomy, gave rise to recurrent attacks of biliary colic. From this point, furthermore, these stones may readily enter the common duct at a later date and give rise to common duct stones.

The operation of choledochostomy has long been considered a very delicate technical procedure which adds a considerable increment of risk and time to the operation of cholecystectomy. With recent improvements in anaesthesia, however, and with certain principles of exposure these factors may be materially reduced and we believe that choledochostomy in the average patient does not seriously increase the morbidity or mortality of cholecystectomy. Adequate exposure of the common duct is the first considera-

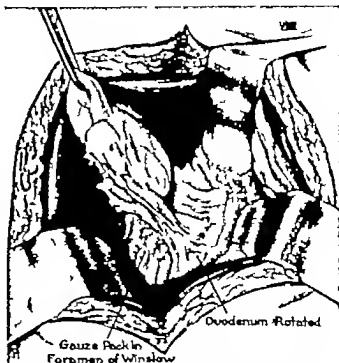


Fig. 1 Exposure of the gall bladder and the common duct area. Note the walling off of Morison's pouch by gauze packing. Note the Deaver retractor laid over gauze which is rotating the second portion of the duodenum downward and toward the midline, thus bringing out the region of the common duct.

tion and adequate exposure can be obtained only by satisfactory anaesthesia. Anaesthesia which does not give relaxation of the rectus muscle which does not prevent straining and bulging of the abdominal contents through the incision is not adequate anaesthesia for cholecystectomy. The best anaesthesia, from the surgeon's point of view for relaxation and exposure is spinal anaesthesia. In patients, however, whose condition is not satisfactory for high abdominal spinal anaesthesia we have found that the use of intra-tracheal ethylene oxygen anaesthesia combined with regional blocking of the area about the wound with one-half of one per cent novocain gives a most satisfactory relaxation and opportunity for exposure of the bile ducts.

Next in importance to anaesthesia in the exposure of the common duct is an adequate incision. This incision we believe should run from the costal margin just a little to the right of the midline, down to the level of the umbilicus or below. We find no objection to a long incision provided its closure is carefully made—we are satisfied that its length is of great importance in the thorough exposure of the common duct.

With a long incision, under satisfactory anaesthesia exposure of the common duct is dependent

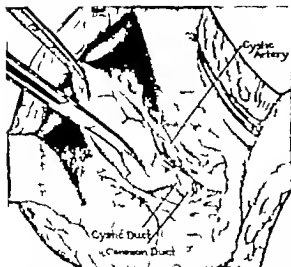


Fig. 2. With traction on the gall bladder incisions are made in the peritoneal coat starting over the common duct and running up each end of the gall bladder. The cystic artery can be seen restricting complete extension of the cystic duct. The common duct and common hepatic duct are coming into view.



Fig. 3. The cystic artery is carefully separated and ligated. This procedure liberates the cystic duct and makes it readily separable from the common hepatic duct. A small pledget of gauze on the right angle snap used as a wiper aids greatly in this delicate dissection.

upon the placing of wet packs above and to the right side of the duodenum and the use of a Deaver retractor which rotates the duodenum downward and toward the midline (Fig. 1). With forceps applied to the gall bladder for upward traction and with downward and inward traction upon the duodenum the tissue in the gastrohepatic omentum is put upon a stretch and the common duct is at once visible in its fold.

The first step in increasing this exposure is to incise the peritoneal covering over the common duct, free it with a small wiper made of gauze and placed on the end of a clamp. The cystic duct and the cystic artery are thus demonstrated (Fig. 2). Ligation and division of the cystic artery at this time will increase the exposure of the common duct very definitely because this permits the gall bladder to be pulled upward to mark out the cystic duct and its relation to the common duct as Lahey has shown (Fig. 3). The next step in the procedure is to dissect the cystic and common ducts with the small gauze wiper so that the junction of the cystic duct with the common duct is clearly and plainly visible. At this time in the dissection the common duct, the common hepatic duct, and the cystic duct should all be directly and freely in view (Fig. 3a). It is our custom to clamp the cystic duct with two right angle clamps, leaving an adequate amount of cystic duct so that the tie will in no way impinge

upon the caliber of the common duct. With a clamp the gall bladder can be lifted up and, with retraction by the Deaver retractor the common duct is made clearly visible.

Incision is now made in the common duct. We make this incision with a very fine pointed knife just below the junction of the common and hepatic ducts with the cystic duct. The wall of the common duct must be carefully inspected before it is incised in order to be certain that no large vessels are present (Fig. 4). If vessels are directly over the point of election for this incision, then, with fine pointed snaps, these are caught very delicately and tied. Failure to do this gives a field which is at once covered with blood when the incision in the duct is made and does not permit clear vision on opening the duct. Immediately the incision in the wall of the duct is made any bile which flows out is removed by a blunt pointed suction tube. The sides of the incision are caught by a long handled Allis forceps, of delicate design which permits the opening in the duct to be held widely apart. The opening in the duct may now be increased in length if it is necessary, up to 1.5 or 2 centimeters.

With the common duct widely opened before us, with the suction apparatus removing any blood and bile drainage from the duct, we explore the common duct and the common hepatic duct to be certain as to the presence or absence of stones or

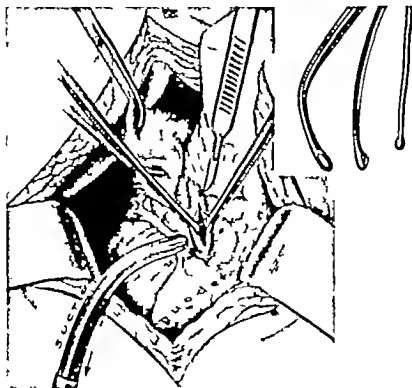


Fig. 4. An incision is made in the common duct and detritus removed by suction tube. The walls of the incision are held apart by long handled, thin bladed Allis forceps. In the insert are shown the right angle forceps used to explore the duct and pick up stones. Next is a bucket shaped stone dislodger with a flexible shaft which occasionally passes by a stone and returns it on removal, and lastly is a uterine probe which is very useful in exploring the common duct.

other obstruction. This is a delicate procedure and one in which there are numerous opportunities to overlook or fail to remove the stones for which we are searching. As yet we have no means at our command which will determine positively after exploration of the common duct that every stone has been removed. We use first a uterine probe which we place in the duct and pass down to the papilla of the ampulla. Normally the ampulla has an opening which is smaller than the lead in a lead pencil and the probe is of course, much larger than this. It is good policy, however if one does not meet with much obstruction, gently to force the uterine probe through into the duodenum. I am satisfied that not infrequently small stones in the ampulla are in this way, pushed through into the duodenum. If the probe meets with considerable obstruction in the ampulla however it is removed and stone forceps are passed downward and opened gently to see whether or not any stones or any detritus are found. If stones are found then repeated passage of forceps of various sizes and shapes is necessary until one is certain that all stones are removed or that at least no further

stones can be obtained. Again the uterine probe is passed and if the duct is apparently all clear then explorations are carried out in the common hepatic duct, in the right side and the left side, to determine whether or not any stones lie in these areas. Finally great care must be taken to explore the stump of the cystic duct in order that no tiny stones be left in that area to pass later into the common duct and cause obstructive symptoms.

When we have satisfied ourselves that no stones or debris remain in the common duct a small catheter is passed into the common duct toward the duodenum (Fig 5). A syringe filled with sterile salt solution is attached to it and the salt solution is washed through the duct. If this salt solution passes readily through the common duct through the paralyzed sphincter at the ampulla of Vater and balloons the duodenum we feel fairly confident that no stones remain in that duct.

A T tube is now selected which is much smaller in diameter than the common duct, which we are exploring and the cross bar on the T is cut down so that the total width of the cross bar is a centi-

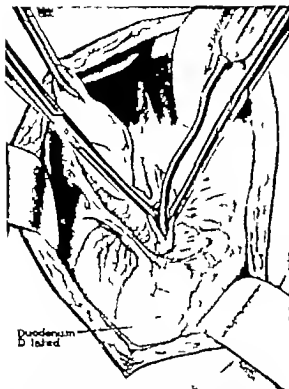


Fig 5 Exploration of the duct has been finished. No further stones can be detected and a soft catheter of small diameter is inserted toward the duodenum. If water flushes through this catheter through the ampulla and dilates the duodenum, it is probable that no further obstruction remains in the duct. Removal of the gall bladder can now be completed in the routine way leaving a peritoneal coat to cover the liver bed.

meter or at most a centimeter and one half. The ends of the T tube are cut on a flare so that when it comes out it will more readily pass through the opening in the common duct. The T tube is carefully inserted, one arm in the upper end of the common duct and the other in the lower end, and with fine chromic catgut sutures swedged on a needle so that no knot is present, the duct is closed about the T tube with one or two sutures (Fig 6). The peritoneal tissues are gently pulled together with interrupted sutures of plain catgut, the cholecystectomy is finished in the usual manner and a cigarette drain or small rubber dam drain, is placed down into Morrison's pouch along side of the T tube in the common duct.

Rarely the common duct will be opened and a stone will be found in the ampulla of Vater which cannot be extricated through the opening in the upper portion of the common duct. This presents a difficult and at times a trying problem. Two

ways are available for removing this stone. The first is a transduodenal choledochostomy in which an incision is made through the anterior wall of the duodenum the ampulla of Vater is opened in the posterior duodenal wall, and the stone removed through the duodenum. This operation, we have never done in the clinic. The dangers of peritonitis, of duodenal fistula or of duodenal obstruction seem too great to make this procedure desirable except in the most unusual case. The better way in our belief to remove a stone from the ampulla of Vater is to incise the peritoneum along the superior and lateral wall of the duodenum and gently turn the duodenum forward. With a probe in the common duct we may now follow the common duct through the head of the pancreas down to the ampulla (Fig 7). Much bleeding is apt to accompany the dissection of the common duct through the head of the pancreas but with patience and care this can be controlled and the common duct can be opened near the ampulla just as the duct is entering the duodenum. The amount of bleeding and difficulty in obtaining exposure of the duct at this point will vary in different people but certainly two-thirds of patients will have considerable pancreatic tissue surrounding the common duct just as it enters the duodenum which bleeds readily and makes the dissection trying and long. We feel, nevertheless, that such a dissection is safer and better than procedures which entail incision in the duodenal wall.

Certain difficulties and complications have arisen in our experiences with opening the common duct many of which have been related to our failure to make a sufficiently large abdominal incision and to the difficulties which we have had in obtaining an adequate exposure of the duct. In certain very fat patients, however, exposure of the duct may be difficult because when the duct is visible the depth of the wound is very great. Bleeding from small and large vessels overlying the common duct has occurred in our experience and may be a serious annoyance in the course of the operation. This, however can be avoided if great care is used in the dissecting, with a pledget of gauze on a clamp of the wall of the common duct so that the exact area for the incision is visible and so that no incision through sizable vessels in the common duct is made. One should not make the incision into the common duct near the point at which it goes under the duodenum. In this area large vessels from the gastroduodenal artery may overlie the common duct and even though they are not cut at the time of opening the common duct they may well bleed later during

the course of common duct drainage. Furthermore, there is also the possibility that the common duct drain may ulcerate through the wall of the duodenum in this area. Therefore, the incision should be made three-quarters of an inch, at least, above the point where the duct goes under the duodenum.

Failure to remove all the stones in the common duct, even when it is open and when one is exploring it, may occur. No surgeon who has opened the common duct with any frequency will deny that he has overlooked the presence of stones in the duct. Small stones which cannot be felt with the finger and which do not give any sensation to contact with the examining probes and forceps, may occasionally be overlooked. If however the ampulla of Vater is well dilated and if the common duct will permit the easy flow of water from a syringe into the duodenum with the catheter placed only a short way down the duct then the duct is almost always patent.

The formation of strictures after choledochostomy is a possibility which has been mentioned as a criticism of the frequent use of this procedure. We have yet, however with our entire experience with choledochostomies to see a patient in whom any stricture formation or any evidence of stricture formation has occurred. The incision, of course, is always made in the longitudinal line of the common duct and never transversely. In the ordinary patient the tube remains in the duct only 10 to 14 days and is then removed. We are very careful not to destroy the mucous membrane of the lining of the duct because we believe that extensive destruction of this mucous membrane would tend to cause stricture formation nor do we use such large T tubes that mucous membrane will be ulcerated by their pressure.

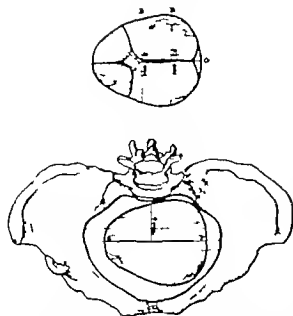
The postoperative management of the patient who has had a common duct exploration and who has a T tube in the common duct is, as a rule not complicated. In those patients in whom the common duct is drained although no stones are found we leave the T tube in place for 8 to 12 days. On the sixth or seventh day after operation the T tube is clamped so that bile goes through the horizontal section of the tube into the intestine. If the stools become brown and if clamping the tube causes no distress and no drainage of bile around it then after it has been clamped off for some 3 days, it is removed on the tenth or twelfth day. The sinus left by its removal rapidly heals, bile rarely drains for over 24 hours, and no further trouble occurs.

In patients in whom stones have been found and in whom there is some infection in the com-



Fig. 6 A T tube with short horizontal arms has been inserted into the common duct after exploration. The common duct is closed about the T-tube after its insertion, and with interrupted sutures the peritoneal layers are pulled over the common duct around the T tube. The bed of the gall bladder in the liver is also closed with plain catgut sutures and a rubber dam drain is inserted in Morrison's pouch beside the T tube after the gauze packing has been removed.

mon duct the T tube is left in for a longer time, often 14 and 15 days. At about the tenth day after operation the tube is clamped for an hour in the morning and an hour in the afternoon. If no trouble arises it is clamped for increasing intervals each day until finally a clamp is left on all the time so that all the bile goes through the horizontal portion of the tube into the duodenum. In these patients, when it is apparent that the bile is flowing freely into the duodenum the tube is removed at about the thirteenth or fourteenth day. Twice in our experience trouble has arisen because in some way the horizontal portion of the T tube became kinked in the common duct, bile could neither go through the horizontal portion into the duodenum nor readily flow out through the vertical portion. In both of these cases after some days, the T tube was removed with immediate cessation of difficulty and final complete drainage of bile into the intestines. In each case, however bile drained through the wound for some days in considerable amounts before the



The SD and OF Occipitofrontal or sagittal diameter. BT bitemporal diameter. AP biparietal diameter. GT greatest transverse diameter. MT available transverse diameter. MT modified transverse diameter. This figure shows the location of the widest posterior transverse diameter of the pelvic inlet of which the sagittal cephalic diameter may avail itself in attempting to enter the pelvis. Such a transverse diameter is called the available transverse diameter and it occupies the same vertical plane as the sagittal cephalic diameter which must pass through it. With the head long transverse and as far posteriorly as possible one end of the bitemporal diameter will be in contact with the sacral promontory while the sagittal cephalic diameter which bisects the bitemporal diameter must be 4 centimeters anterior to the promontory as most likely available transverse diameter of pelvic inlet.

It will be impossible for a normal fetal head to pass through a normal or simple flat inlet as a left occiput posterior or right occiput posterior even if originally presented in that position. This as explained in a previous paper (2) is due to the fact that the respective sacrocotyloid diameter (the distance between the sacral promontory and anterolateral border of the inlet) is not as great as the biparietal cephalic diameter which would have to pass through it (Fig. 2). Consequently arrest of the biparietal region takes place followed by deflection and substitution of the occipitofrontal for the suboccipitofrontal diameter as the presenting sagittal diameter of the head. As a result of this lengthening of the long axis of the presenting cephalic ovoid its frontal area will hit against the anterolateral border of the opposite margin of the inlet and will be deflected posteriorly until it lies in trans-

verse position in which it will then sink into the pelvis (Fig. 2). In abnormally large pelvis in which however the normal relationship between the various diameters is preserved, the head may enter as a left occiput posterior or right occiput posterior if it is originally offered for passage in that position since in such pelvis the sacrocotyloid diameter may be sufficiently large to permit the passage of the biparietal cephalic diameter. In making such engagement possible, abnormally large pelvis may contribute to the occurrence of a dystocia dependent upon such engagement. If furthermore in association with such pelvis the head is originally offered as a direct posterior occipital presentation it may enter as such or partial rotation may occur either to the right or left oblique posterior position, in which it may enter the pelvis or from which further rotation anteriorly may occur before actual passage through the inlet. When such rotation is to the left namely to a left occiput posterior further rotation anteriorly is more apt to occur than when it is to the right (right occiput posterior) since it is less easy for the head to enter the inlet as a left occiput posterior than as a right occiput posterior. This is due not to the presence of the rectum on the left side but rather to the fact that the left oblique diameter is usually shorter than the right oblique since the majority of people tread more heavily upon their right foot, this influencing to some degree the configuration of the pelvis during the years of its growth. Thus when the left oblique is not long enough to permit ready passage of a left occiput posterior presentation, the same factors come into play to convert it into a left occiput transverse as in left occiput posterior presentations in the presence of simple flat and normal pelvis (Fig. 2).

A similar chain of events may follow when an unusually small fetal head is presented for passage through a normal pelvis, as in the case of a normal head in relation to a very large pelvis. There is another rather frequent type of pelvis, namely one in which the true conjugate is absolutely or relatively increased in relation to the transverse diameter which is actually contracted. Thoms has called attention to this type and we ourselves have observed several cases. The inlet is irregularly oval, greater in length than width with its posterior region slightly wider than its anterior portion. When the head is presented to such a pelvis with the occiput pointing anywhere posterior to the transverse position, it will usually rotate to the direct posterior position during the mechanism of engage-



Fig. 2 SC Sacrocytyloid diameter BP biparietal diameter This figure shows that arrest occurs along the line SC which is shorter than the biparietal diameter. Arrest is followed by deflection which increases the length of the anteroposterior cephalic diameter the frontal portion of the head meeting the pelvic resistance at *R*, whence it is directed posteriorly by the counter resistance *XR* along the line *RP*.

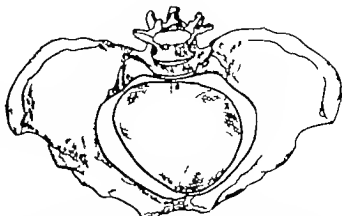


Fig. 3 This figure shows that an oblique diameter such as *DC* is longer than a transverse cephalic diameter such as *DX*. The mechanism that is brought into play when the true conjugate is shorter than the cephalic diameter *DC* which measures about 10 centimeters and which causes rotation to the transverse position is explained in reference No. 2.

ment, and such position will tend to persist as the head descends through the entire pelvis (3). The possibility that a deep posterior position of the occiput may be associated with such a pelvis casts doubt on the wisdom of attempting cephalic rotation with forceps to an occiput anterior position if the slightest difficulty is encountered in carrying out this procedure. It is far better to permit delivery as an occiput posterior in such cases, since here the posterior sagittal diameter of the outlet is usually also relatively large the pelvis is relatively narrow throughout its extent and there is less danger of injury to mother or fetus than if attempts are made at rotation.

In normal as well as in proportionately enlarged pelves, the head may enter the inlet as a left occiput anterior or right occiput anterior but as the true conjugate becomes progressively shorter there will be an increasing tendency for rotation to occur to the transverse position until in simple flat pelvis passage through the inlet is impossible unless such rotation has occurred. This is due to the fact that when the head occupies an obliquely anterior position the particular cephalic diameter which must pass through the true conjugate is larger than the one which is offered for passage through the true conjugate when the head is lying transversely (Fig. 3). It is in this fundamental respect that the writer's conception of the factors influencing engagement in simple flat pelvis differs from that usually described (2). With equivalent degrees of shortening of the true conjugate this tendency to transverse rotation is greater in right occiput anterior than in left occiput anterior presentations due to the

fact that the left oblique inlet diameter is often shorter than the right oblique.

In generally contracted pelvis in which there is transverse as well as anteroposterior shortening of the inlet, the head will tend to engage in whatever particular diameter it originally approaches the inlet. The latter is irregularly round instead of oval or kidney shaped as a consequence of which factors which otherwise might favor rotation of the head into a more suitable diameter than perhaps the one in which it was presented, are entirely absent. In such cases extreme flexion and molding are the only means which may make possible the descent of the head through the inlet.

SUMMARY

It has been shown that the prevalence of left occiput anterior presentations is due first of all to the fact that uterofetal accommodation is such that the head is more frequently brought to the inlet in that position. Subsequently it is due to the fact that the relationships between the various cephalic and pelvic inlet diameters are such as to maintain that position when they are normal and to the fact that equivalent degrees of variation from the normal dimensions are less apt to alter this position than any other one. In the latter there is a marked tendency for rotation to be effected to one of the transverse positions of the occiput which then rank next in frequency to left occiput anterior presentations. It would seem that the head is able to pass through the inlet as a frank or oblique posterior occipital presentation only in generally

contracted pelvis, in pelvis which though large show an actual or relative transverse contraction together with an anteroposterior lengthening and finally in unusually large pelvis in which the various diameters are normally related

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THE TREATMENT OF VARICOSE VEINS

ANATOMICAL FACTORS OF LIGATION OF THE GREAT SAPHENOUS VEIN¹

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IN recent years we have been forced to return to ligation of the great saphenous vein in the treatment of certain cases of varicose veins. The injection treatment alone fails to give permanent cure in those patients in whom there is great widening of the saphenous veins. In those cases the valves are incompetent and the flow of blood in the vein is reversed; that is, it is downward from the saphenofemoral junction to the varices.²

Howard *et al.* first demonstrated that in such a vein there occurs recanalization of the segment sclerosed by injection. The recanalized segment may be the varix itself or the blood may course through it to re-dilate a varix below (Fig. 1). The blood may also be sufficiently diverted through a previously normal collateral to dilate it. Then the blood may flow freely through this second collateral to dilate the varix below.

We have thus come to a realization that the injection treatment is not a cure all. We must again concern ourselves with the abnormal physiology of varices, especially with the abnormal reflux from above in the severer cases. These must be treated by something more than injection alone. It is necessary to remove the baneful effect of the pressure of the refluxed blood, which breaks up the newly formed clot, or dilates the

previously normal collateral. Further in this paper will be discussed the production of incompetence of the valves of previously normal collaterals (Fig. 2).

It is interesting that in receding from our erstwhile overenthusiasm for the injection treatment we arrive at the same procedure that Tavel, in 1904, came to in proceeding from the purely operative view. In discussing the disappointing results from simple ligation, he observed "My impression was also that the results were more generally favorable in those cases (after ligation) with spontaneous thrombosis than in those without, which led me to attempt an artificial thrombosis to give an even better result." He therefore carried out a preliminary ligation of the saphenous vein, and followed this, in 24 to 48 hours, by injections of 5 per cent phenol. Considering the unfavorable sclerosing agent he used, his results were very good.³

Schlasi in 1908 next adopted this combined treatment (20, 21). Schlasi was impressed by the value of the sclerosis to be obtained by injection. (He used a solution of iodine and potassium iodide.) He considered, however, that a preliminary ligation would give additional guarantee against any chance of embolism. Accordingly he excised 2 or 3 centimeters of the saphenous magna, above or below the knee, and injected 30 to 50 cubic centimeters of his solution into the distal segment.

Coming forward to our present era we find Moskowitz of Vienna, reporting, in 1927 on a preliminary ligation of the saphenous vein, followed by injections of dextrose solution into

The demonstration of the reversed flow is called the Trendelenburg test. (1) Trendelenburg description made. Lay the patient flat, lift the leg up, actually the varices empty. Now compress the saphenous magna with the finger. Stand head up quickly. The varices fill slowly but not as much as previously. Now let the finger go, and the varices fill very quickly and fully by columns of blood which is seen to descend downward in the saphenous magna.

This is now commonly called a *double positive Trendelenburg test*. It denotes competency of the saphenous valves.

The term *negative Trendelenburg test* refers to that result in the above experiment, in which there is no increased or rapid distention of the varices either before, or after the compressing finger is removed from the saphenous. It indicates incompetency of the valves of the saphenous as well as of the perforating veins connecting the deep with the superficial veins.

A *double positive Trendelenburg test* shows itself as: (1) quick filling of the varices, before the release of the saphenous, as well as (2) downward reflux after its release. It indicates (1) incompetency of the above of the perforating veins with flow from the deep to the superficial veins (the reverse of normal), as well as (2) incompetency of the valves of the saphenous veins.

For the sake of simplicity I use, throughout the paper, the term ligation to include preliminary section of the vein. I have been disappointed for centuries that simple ligation of blood vessel may allow the lower of the ligated point to be re-established, usually by absorption of the ligature or its cutting through the vessel. If the vessel is first sclerosed, however, and then ligated, this will not occur. This is, I believe, basically conceded axiom in vascular surgery.

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the distal segment. His reasons for doing this are first, that percutaneous injections may give sloughing second that the danger of embolism is obviated by the ligation of the main trunk.¹

DeTakats is to be credited with a return to a preliminary ligation, for the type of case under discussion (that with a positive Trendelenburg test) from a hydrodynamic viewpoint. A similar procedure has been evolved at the peripheral circulatory clinic of the Massachusetts General Hospital and reported by Faxon of that Clinic. It has, I believe, certain peculiar advantages (5). They perform the ligation at the saphenofemoral junction, and inject sclerosing solution (a mixture of invert sugar and sodium chloride) into the cut distal segment. They also divide all the entering tributaries of the saphenous to be found at the operative level. At the Boston City Hospital, we have adopted this procedure for cases showing a positive Trendelenburg test, and we have been using it since the middle of 1932.

HISTORY OF SAPHEOUS LIGATION

The history of saphenous ligation is literally one of upward progression (Fig 3). Hippocrates directed the making of small punctures over the varices proper but forbade free incisions. Celsus (1st century A.D.) made incisions along the varices at intervals of four fingers breadth, then touched the vein in the depth of the wound with the cautery, then grasped its ends and tore out as much vein as possible.

Ætius, in the 6th century and Paulus Æginata in the 7th century A.D., were probably the first to adopt actual section and ligation of the saphenous vein itself. The operation is fully described by Paulus and is striking in its similarity to that of modern authors. We must credit him with having recognized enough of the anatomy of the saphenous and its branches to attempt an approach on the veins sufficiently high to secure, as he thought, the main trunk from which all the branches arise. He states those (varices) in the leg may be operated upon in a similar manner *making the attempt upon those in the inner part of*

¹ Concerning sloughing: 'The injection acts from escape of the solution into the peri-venous tissues with reasonable care and experience, this should occur but infrequently.' In our clinic at the Boston City Hospital, even a small point of necrosis is seen no more frequently than once in every hundred injections.

Concerning the production of embolism in the percutaneous injections: though an occasional embolism has been reported in the literature, our experience has been very favorable. 3,045 cases have been treated, from the inception of the circulatory clinic in 1929 to January 1, 1934. The number of injections has been approximately 30,576 yet to my knowledge embolism has never occurred. Probably the greatest single factor of safety we possess in this clinic is the extremely ambulatory nature of our clinic, and the active types of occupations pursued by our patients. I think very rare and the formation of stagnation thrombi in the veins, adjacent to the area in which there has been the formation of a firmly adherent clot, secondary to chemical irritation of the intima. As DeTakats has pointed out embolism is more apt to arise from the stagnation thrombi (3).

the thighs where they generally arise, for below this as they are divided into many ramifications they are more difficult to succeed with

The ancient surgeons that followed were apparently divided into two groups: those who operated on the leg itself according to the method of Celsus, and those who ligated the saphenous according to Ætius and Paulus.

Coming forward to a much later date we find Ambrose Paré (1579) ligating the saphenous just below the knee quoting Paulus however, for the actual technique (17). Paré states one attacks the varix in the upper part of the leg, a little below the knee where most of the varices are found and take their origin. One incises (first) to let out the blood and other humors contained in the varices which flow to the ulcers located below on the leg; or, (second) because the vessel is so greatly distended with blood that it may break, producing the death of the person by reason of great hemorrhage. Trendelenburg criticizes Paré for undertaking the operation with misguided notions of the circulation of the blood in the veins. Nevertheless, Paré was first a clinician, and it is not to be thought that, in those days of sepsis and no anesthesia, any person with varices came for surgical treatment unless the disease was so far advanced that there was actually a reversed flow in the superficial veins of the leg.

For the next two centuries the operation was seemingly discarded. At the end of the 18th century appeared an excellent work on the treatment of ulcers of the legs by Everard Home, brother-in-law of John Hunter. He writes: 'An enlargement of the veins produces also another effect. The coats of the vessels and the valves become thickened which renders the valve less pliant, they do not occupy the whole area, and therefore are no longer of any use and from this defect the whole length of the column of blood in the vena saphena is in the erect position pressing upon the contents of the smaller veins, so as to dilate them still more and more and keep the limb always in a weak state.' He proposed to take this pressure off the varices by making an artificial valve, by ligating the saphenous at the knee.

He is later quoted by Sir Charles Bell as stating that the pressure on the varices is not only that of the blood contained in the saphenous vein but also 'the whole column of blood presses from the head and heart upon the veins of the leg!'² Home continues: 'Cases occur in which there is

² 'We are indebted to Sir Everard Home for this improvement in surgery (saphenous ligation) the further merit of instructing the operation from a previous careful investigation of the pathological principle.' (1)

a smaller vein running parallel to the vena saphena. Thus, when the vena saphena has been taken up afterward becomes enlarged, and continues the disease when that is the case this vein must also be taken up. These circumstances ought to be attended to in the first examination of the disease as sometimes the two veins are so close together that they may both be included in the same ligature. One may cite with interest one of his case reports, that of Case II Sarah Stapleton operated on in 1794. In the time of operation, a smaller vein was opened running parallel to the vena saphena, which afforded a reasonable suspicion that the disease might recur.

Fifteen months after the vena saphena had been tied a vein in the place where the ulcer had formerly been situated burst and bled freely.

"Upon examining the vena saphena, at the part where the ligature had been applied, two very large veins were discovered so that there must have been at the time of the operation, two small branches, one on each side of the vena saphena one of these only had been observed at the former examination. These two veins were now included in one ligature.

The celebrated Langenbeck apparently used the operation of saphenous ligation. A comment in 1860 on one of his cases is interesting. "In a case of very large varices of the vena saphena in a young man I extirpated about 3 inches (Zoll) of the dilated vein and ligated the upper and lower ends. One year later I found a new venous trunk the width of a crow quill, in the region of the extirpation scar which (vein) had reconnected the well dilated ends of the saphenous.

The presence therefore of collaterals of the saphenous which could take over its flow to the varices below was known before Trendelenburg's time. In that intervening century too descriptive and artistic anatomy reached a high degree of accuracy. Such works as that of Spalteholz, Toft, Testut, Braune picture the saphenous and its collaterals very well. Trendelenburg in his work on ligation makes specific reference to the paper of Karl Klotz. Klotz figured and described branches of the saphenous communicating freely with those of other levels, as well as actual reduplications of the main trunk by somewhat narrower collaterals.

Trendelenburg writes. Not seldom there occurs reduplication of the stem of the saphenous in longer or shorter extent, and when both these stems are varicose the ligation can be a success only when either both are ligated, *or the vein is seized above the doubling.*" In spite of this he proceeds to dictate "Usually the appropriate

site for both finger compression and ligation is at the junction of the lower and middle thirds of the thigh this being the usual site of great dilatation.

In 1895 5 years after Trendelenburg had published his paper Georg Perthes reported his results with the operation. Of 41 cases which had been followed up 9 patients showed recurrence. In all of these there was either a regeneration of the saphenous in the form of a single trunk or in the form of many branches. In one case a small packet of tissue at the ligation site was excised and it showed many outbranchings, running downward from the dilated end of the saphenous. Most of them ended blindly but the widest of them circled close to the ligation site, and communicated with the upper part of the dilated peripheral end of the saphenous. He concluded "It seems that in cases in which the saphenous is not present as a solitary trunk, or shows many ramifications, it were best to perform the operation high above. The higher the main trunk is ligated the fewer will be the number of branches above the ligation site and the less likely will be the chance for the varices again to come under the influence of the blood's pressure. In cases of large varices spread over the entire limb one can show that a compression right at the entrance of the saphena magna in the femoral has a definite effect on the Trendelenburg test while at all other sites there is either no effect or it disappears quickly. This is therefore preferred as the site of election for operation in these cases. Though one of his case reports (No. 41) contains this recommendation, I do not know whether he actually performed this high operation.

In 1896 a year later Moore of Melbourne reported on a modified Trendelenburg operation. He wrote "Site of ligation. As the operation aims at preventing any reflux of blood into the vena saphena and its branches, this object is surely much better attained by ligaturing above the junction of any of the branches belonging to the lower extremity. If the ligature is applied low in the thigh this object is not attained with the same certainty. Though he evidently intended to operate at the fossa ovalis, he directed the making of the incision 3 inches below Poupart's ligament. Moore performed the operation in the out patient department, applied a collodion dressing and allowed the patient to go home immediately. He reported no untoward effects.

It remained for John Horns of Boston in 1916 to insist that the ideal operation for varicose veins was to ligate the saphenous and all its

It is to be noted that Trend stated that, when the person reaches the knees or thighs, the operation is done at the saphenofemoral junction ()

terminal branches at the saphenofemoral junction and to follow this by an excision of all the varices below (7, 8). I believe that this opinion, from the operative viewpoint does not differ in principle from the opinion from the injection viewpoint. In other words, in either case, the ligation is done to remove the dilating effect of the back pressure of the blood and the subsequent sclerosis of the veins below is directly comparable, in its effect, to their extirpation.

CLINICAL

My attention has been the more directed to the correct level for ligation by patients showing recurrence of varices after improper operation. We have seen at the Boston City Hospital many such cases. I shall cite 2 case reports illustrating the recurrence after simple saphenous ligation and excision, and 2 cases showing recurrence after the present day procedure of ligation and retrograde injection of the saphenous vein.

CASE 1. F. H. (B. C. H. No. 38924) a night watchman aged 63 years, was operated on for varicose veins of both extremities 15 years ago. The varicosities disappeared until 3 or 4 years before present examination. About three months before examination a large ulcer appeared on the lower anterior surface of the right leg. Examination disclosed an operative scar on the medial surface of the right lower extremity commencing 7 inches below the pubic tubercle then running down to within 5 inches of the medial malleolus. A second scar extended downward and forward for 8 inches from this first scar in its lower extent. A third scar of 9 inches was seen on the anterior surface of the leg. A large excavated ulcer 3 inches in diameter was situated below the terminal ends of the scars. A large group of tortuous varices, the diameters varying from 1 to 1.5 centimeters were present on the anterior, medial aspect of the leg. Above one could see and feel the stump of the saphenous vein above the long scar and from its lower extremity collaterals running on either side of the scar to feed the varices below. The Trendelenburg test was singly positive. The venous pressure in the upper part of the saphenous vein was 30 millimeters mercury rising to 40 millimeters during the Valsalva experiment. In one of the varices below the knee the pressure was 42 millimeters mercury rising to 82 millimeters on performing the Valsalva experiment.

Here apparently was an extremity in which extensive dissection of the great saphenous vein and its varices had been done. The vasogram confirmed the gross appearance, however, of regeneration of the varices through communications with the stump of the saphenous vein (4) (Fig. 4.)

CASE 2. J. L. (B. C. H. No. 30357) a Swedish baker of 35 years, who was refused admission to this country because of large long standing varices in his left leg. He was therefore operated upon in his native country then allowed to enter the U. S. After being here one year the varices returned. Examination showed varices up to 1.5 centimeters in diameter all along the medial aspect of

the left leg and lower thigh. There was an operative scar along the line of the saphenous vein starting at the junction of the middle and lower thirds of the thigh and extending down to mid leg. The venogram disclosed as in Case 1 a reformation of the varices by a downward flow through a large collateral of the saphena magna (Fig. 5.)

CASE 3. D. G. (B. C. H. No. 211074) a restaurant worker of 34 years, had varices of both legs, the largest ones were in the right leg. The saphena magna and its branches in the right thigh and leg were widened up to 1 centimeter in diameter. The patient complained of cramping on walking and of an itching dermatitis of the lower leg. The Trendelenburg test was singly positive. He entered the Boston City Hospital on December 5, 1932 where section of the saphena magna vein was done and 15 cubic centimeters of varicel injected into the distal segment. On January 13, 1933 5 weeks later, the patient returned to the vein clinic. He stated that his symptoms were entirely relieved. Examination showed a 3 inch transverse scar about 3 inches below the pubic tubercle. From the lower part of the scar the saphenous vein could be felt as a well sclerosed cord down to about the middle of the thigh, but from here downward it could be seen and felt to contain a good sized lumen. Running into the lateral aspect of this open part of the saphenous could be seen a dilated system of veins. Figure 6 is a composite tracing of 2 venograms made of this limb at this time. The superficial lateral femoral vein is seen to be responsible for the communication between the terminal part of the saphena magna above and the same vein below.

CASE 4. J. D. (B. C. H. No. 64763) a laborer of 53 with moderately severe diabetes of many years' duration and arthritis of both hips with partial ankylosis. Nineteen years ago he first noticed a spontaneously appearing ulcer of the left leg. In August, 1931 varices in this leg were noted and injections of quinine urethane started. In July, 1933 he had already had 43 injections with persistence of the ulcer and the appearance meanwhile of a smaller ulcer on the right leg. The great saphenous vein and its branches were palpable on each side in spite of the fact that they had presumably been sclerosed. The varices in the legs varied up to 1.5 centimeters in diameter. The Trendelenburg test was singly positive. Ligation and retrograde injection of both saphenous veins was carried out on July 31, 1933. One month later the saphenous veins were entirely sclerosed and the ulcers healed. The patient volunteered the information that a feeling of pressure in the legs had disappeared. In the next few months, however the sensation of pressure and pain in the legs returned. Examination December 7, 1933 showed the presence of patent great saphenous veins from just below the end of each vertical scar. These scars started 3 inches below Poupart's ligament and continued for a distance of 3.5 inches. There was visible a dilated superficial vein lateral to the scar. Figure 7 shows the interruption of the saphenous vein in the region of the scar but a good sized stump lying above the scar with a bridging of this gap in the saphenous by a rete of lateral femoral cutaneous veins.

It happens that in 3 of these 4 cases the lateral superficial femoral vein was responsible for bridging the gap in the saphenous vein. However I have seen almost as many cases in which the medial superficial femoral vein or a medially situated collateral vein was responsible.

In contradistinction to these failures quoted is a large group of cases in which patients have

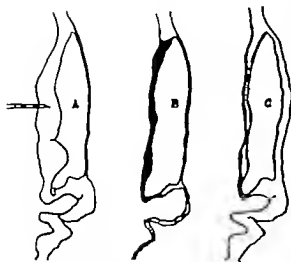


Fig. 1. The two modes of recurrence of a varix. In A, solution is being injected into the middle of a dilated venous trunk. A normal collateral also communicates with the axis below. In B the entire dilated trunk is obliterated and the vein below is collapsed. In C, the varix has been reformed by (1) recanalization of the previously sclerosed trunk and (2) dilatation of the previously small collateral. Either or both of these processes may occur in any given case.

been treated at the Boston City Hospital by ligation at the saphenofemoral junction with retrograde injections of the saphenous vein and subsequent injections of the varices below. We have been able in this way to obtain cures in many cases in which patients had previously had as many as 100 injections in a futile attempt to cure large varices and ulcers.

The question now presents itself. Just how high must one operate in order to be sure of securing the origins of all collaterals to the veins below? I have indicated that the accumulated evidence of the past would prove that the operation of ligation could be successful only if done at the saphenofemoral junction (*fossa ovalis*). Nevertheless, surgeons even today are placing their incisions anywhere from Poupert's ligament to the knee.

ANATOMY¹

Anatomical studies were carried out to ascertain at what level of the saphenous one may expect all the tributaries and collaterals finally to have ended. Dissections of fresh material as well as classroom dissection specimens were used. It was found possible to see the finer branches, the valves, and the perforating veins to the deep venous system, only in the fresh specimens.

¹ I have been assisted in the dissections cited in this section by my teacher, Mr. Jesse E. Edwards, student at Tufts College Medical School.

Figure 8 shows a diagram made from such a dissection. It illustrates the most commonly described type of superficial venous system. The *vena saphena magna* is seen to start as a continuation of the medial end of the dorsal venous arch of the foot. It ascends in the leg from a point anterior to the medial malleolus, to a point posterior to the medial femoral condyle, receiving many intercommunicating tributaries. These form a true collateral, posterior to main trunk.

In the thigh there are no grossly visible anastomosing tributaries above the mid thigh. The saphenous ends in the femoral vein at the *fossa ovalis*, the upper medial corner of which is 15 centimeters below and 2.5 centimeters lateral to the pubic tubercle. Here at its terminal part enter five groups of tributaries: (1) a lateral superficial femoral vein with a narrow superficial ramus and a wider deep ramus; (2) a group of medial superficial femoral veins; (3) a superficial circumflex iliac vein; (4) superficial inferior epigastric veins; (5) a superficial external pudendal vein starting in this case as a continuation of the dorsal vein of the penis. Noteworthy is also the absence of deep communications in the thigh, and the presence in the leg of several such perforating veins in typical locations, viz: (1) at and below the knee; (2) mid leg; (3) at the ankle and in the foot. (One of these is large and constant, accompanying the dorsalis pedis artery to the sole of the foot.) Rather typical is the presence of valves at the mouths of the perforating veins in the leg, preventing a reflux from the deep veins. In the foot the valves are either absent, or more commonly are present and direct the blood outward.

Two communications may be seen to the *vena saphena parva*. This latter is atypical, starting as a perforating vein and receiving the lateral end of the dorsal venous arch only as a tributary. The *saphena parva* presents a typical perforator in its mid part, and ends in the popliteal vein, first running beneath the fascia for some extent.

The venous system shown in Figure 9 illustrates a high collateral of the *saphena magna*. There are two perforators in the mid and lower thigh—typical locations for their appearance. The lateral superficial femoral vein is low arising from the collateral. The *vena saphena parva* ends in the terminal part of the *vena tibia* anterior before the latter enters the popliteal. Before the *saphena parva* ends it receives, under the fascia, the *vena femoropoplitea*, or posterior femoral cutaneous vein which connects it with the inferior gluteal veins. The great saphenous veins figured in Figure 10 show large collaterals



Fig. 2. Photograph of a saphenous valve in section, after its flaps had been set to prevent back flow. Note the length of the flap in contact with its fellow. This particular valve would become incompetent if the vein dilated to twice its diameter. Clinically normal veins may dilate from three to ten times their original diameter when put under the stress of an unusual blood flow as in Figure 1. X5

stretching from the saphenous high in the thigh to the same vein some distance below. They are evidently worthy of the term reduplications of the saphenous.

The dissecting room material was valuable for statistical data concerning first, the actual location of entering tributaries and second the actual location of the fossa ovalis (Fig. 11). Thus this material enables one actually to project on the surface the position of the structures as usually encountered. Twenty-one extremities of thirty cadavers were used, the remainder being discarded because the students had dissected away the superficial structures. Attention was paid only to the terminal part of the saphenous because the previous work as quoted, had indicated that its lower portions were obviously out of the question as a site for ligation. The accompanying diagrams show the main entering tributaries of the terminal part of the saphenous and the distance of these entrances from the lower edge of the fossa ovalis indicated in centimeters.

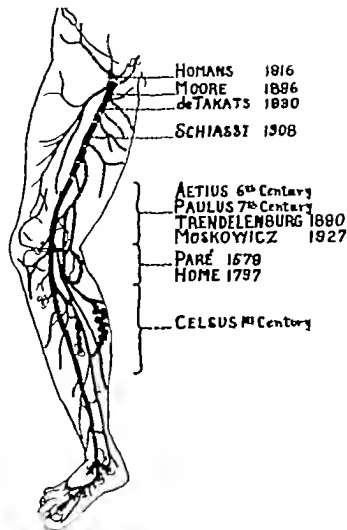


Fig. 3. The history of saphenous ligation showing the upward progression of the elective site of operation.

The diagrams are drawn to scale for these measurements. The fossa ovalis itself is located by measuring in centimeters the distance from the pubic tubercle to its supermedial angle, both in a vertical direction (downward) and in a horizontal (laterally).

The superficial circumflex iliac, inferior epigastric, and external pudendal veins were for the most part removed in previous dissections and are not shown in most of the diagrams except as they may enter together with the tributaries from the thigh. One or more of the three veins noted above may pierce the cribriform fascia above the saphenous and enter the femoral vein independently of, or together with the saphenous.

From below two rather constant veins or groups of veins are seen the lateral and medial superficial femoral veins. The lateral is frequently the highest of these to end entering the femoral proper above the saphenous or the saphenous directly at its termination or the saphenous

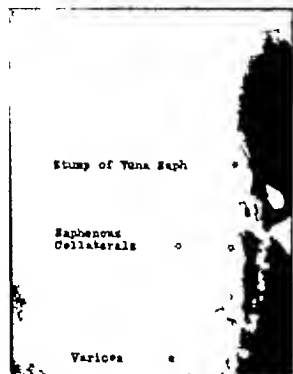


Fig. 4. Case 1. Regeneration of aneur after low excision of the saphenous vein. The venogram was made with the patient standing and without the application of tourniquets. The injecting needle was thrust into the saphenous stump and 15 cubic centimeters of 40 per cent skiodan injected. Not () the rich anastomosis between the stump of the saphenous vein and the reformed aneur below () the downward flow of blood plus skiodan, positive Trendelenburg test.

nous within a few centimeters below the fossa ovalis. It sometimes receives the superficial circumflex iliac vein as it ends.

The medial superficial femoral vein usually terminates at a lower level than the lateral. It may receive the superficial external pudendal vein as it ends.

Distally the medial superficial femoral vein may wind around the thigh to end posteriorly by anastomosing with the inferior gluteal veins. The superficial external pudendal vein anastomoses with the deeper internal pudendal veins. Because both the inferior gluteal and internal pudendal veins are tributaries of the hypogastric (internal iliac) vein, obstruction in either the femoral or external iliac veins above the saphenous or the hypogastric vein, may result in a dilatation of the medial superficial femoral or the external pudendal veins.

In many instances (especially in the veins figured in Figure 10) large collaterals are seen



Fig. 5. Case 2. Regeneration of aneur after low excision of the saphenous vein. The venogram was made with the same technique as that used in Case 1 (Fig. 4). Reprinted from the *Am. England J. Med.* 1933, vol. 15.

stretching between the upper and lower portions of the saphenous. Further it becomes evident from the clinical cases that when the branches take a course near the parent trunk the intercommunications that are ordinarily insignificant may become enlarged after interruption of the trunk below their origin so as to result in large, grossly visible reduplications of the saphenous. From my dissections I can say that the chances are unlikely that the upper three of the saphenous tributaries, i.e. the superficial external pudendal, inferior epigastric, and circumflex iliac veins, may effect any important communications with the saphenous below. An exception to this is the occasional instance when these veins terminate in common with the lateral or medial femoral cutaneous veins.

I may note here that in dissecting the region of the saphenous termination one is struck by the fibrous consistency of the deep surface of the overlying superficial fascia. This fibrous tissue is the continuation downward of Scarpa's fascia of the abdomen. Though this fascia is adherent to the fascia lata just below the inguinal ligament it does not end there but continues

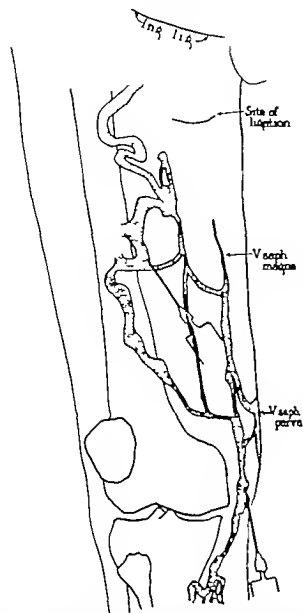


Fig. 6 Case 3. Regeneration of varices after saphenous ligation and retrograde injection of sclerosing solution. Composite tracing made from two venograms. Two separate injections were used with the patient standing up and without tourniquets. The contrast material for each injection was 20 cubic centimeters of a 20 per cent solution of sodium iodide. (I am not using this material any longer because of (1) poor contrast and (2) phlebitis following the injection.) The lateral femoral cutaneous vein is seen to be responsible for bridging the gap in the upper part of the saphenous vein.

downward to end gradually in the middle third of the thigh.

Localization of the fossa ovalis by measurement from the pubic tubercle gave the results shown in Table I.

I believe that in any case the surgeon may check his determination in the horizontal line by searching for the fossa about 1 centimeter medial to the pulsation of the femoral artery.

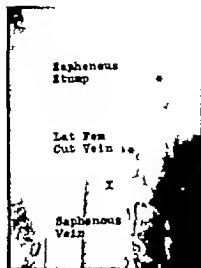


Fig. 7 Case 4. Regeneration of varices after ligation and retrograde injection of sclerosing solution. Venogram made with patient supine. Injection of 20 cubic centimeters of 35 per cent neoskiodan into the dilated lateral femoral cutaneous vein. Note (1) the lateral femoral cutaneous vein bridging the gap in the saphenous vein caused by excision of a segment. (2) the femoral vein. It is indistinct because of the dilution of the neoskiodan, and also because of the movement imparted to it by the pulsations of the femoral artery.

TABLE I

	Horizontally	Vertically
Distance from pubic tubercle to upper inner angle of fossa ovalis		
Mean average	3.9 cm	1.7 cm
Longest distance noted	6 cm	4 cm
Shortest distance noted	2 cm	0 cm

That is, the fossa is on the same level as the pubic tubercle.

PRODUCTION OF INCOMPETENT VENOUS VALVES DURING TREATMENT OF VARICES

In referring to the recurrence of varices a question arises as to the ability of the normal collateral to stay normal (Fig. 1). Of course these communications may be widened concomitantly with the main trunk or the most prominent varix. In that case the blood will course through it unimpeded and continue to distend the varix below, even after the main trunk has been injected. Many of these collaterals, are at first however of normal diameter and well equipped with adequate valves. Through these no blood will at first be refluxed. When however the main trunk is interrupted by sclerosis or ligation the entire blood mass coming down the stump of the main trunk will now be diverted into the collateral. Being of thin walls the collateral soon begins to dilate. How much dilatation of a vein is necessary before its valve flaps cannot meet and thus become incompetent can be answered by the following procedure.

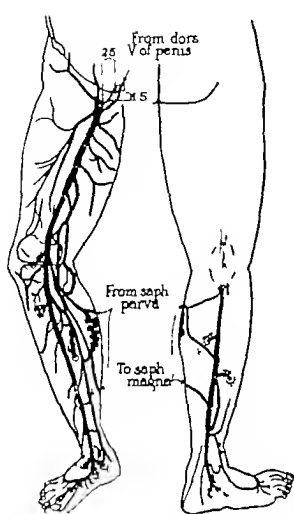


Fig 5 Dissection of the saphenous vein, their branches, communicating veins and valves. The valves are indicated in white. The arrows point the direction of blood flow through perforating veins to or from the deep veins.

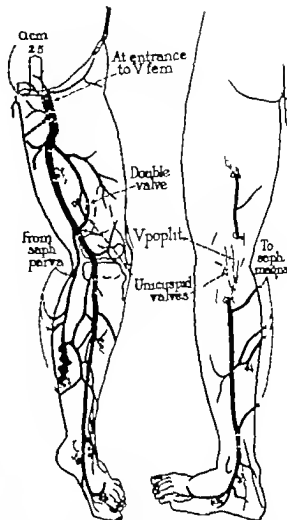


Fig 6 Dissection of the saphenous veins, their branches, communications, and valves. The valves are indicated in white. The arrows point the direction of blood flow through a perforating vein to or from the deep veins.

Section of veins containing valves, were removed from fresh cadavers. These veins were not fixed, in order to avoid the hardening, shrinking and distortion of the delicate flaps. Each segment was hung vertically in the position it assumed in the intact body by means of hooks. The lumen was then carefully washed with normal salt solution, then the vein segment was lowered into Delafield's hematoxylin solution. After the stain had acted for 2 minutes, the vein was rinsed in water and then carefully dried with absorbent cotton. A concentrated solution of gelatin was made of such consistency that it hardened almost immediately on removal from

the water bath. With a pipette this hot gelatin was dropped into the valve sinus behind each flap, thus pushing the valve flaps against each other and closing the valve. The remainder of the vein, proximal to the valve, was then filled with the gelatin. After the gelatin had hardened, the vein was hung in a reversed position so that the collapsed segment distal to the valve could be filled with the gelatin.

The gelatin filled vein was then transferred to the freezing microtome and thick sections made longitudinally from the middle of the vein, and at right angles to the line of the flap edge. Gross photographs from these sections show the actual

amount of the flaps in contact with each other during their setting to prevent back flow (Fig 2). The length of flap in contact with its fellow measures generally from 0.2 to 0.5 of the diameter of the vein as measured across its center from wall to wall and at right angles to the plane of the flap. Because the length of two flaps has to be taken into account the flaps will not be able to meet when a dilatation of the vein occurs equivalent to from 0.4 of the original diameter to the whole of the original diameter.

Clinically, the coming into vision of a vein which had previously been too small to be seen usually means a dilatation of 3 to 10 times. It follows that at least by the time previously normal collateral veins of small size become large enough to be seen that their valves must have become incompetent and a back flow established through them, to dilate the varix below.

PECULIARITY OF VARICES OF LESSER SAPHENOUS

It has been my experience that varices of the lesser saphenous no matter how large they may be can be successfully obliterated by the injection treatment alone. This is in contradistinction to the large varices of the great saphenous, as previously noted. In searching for a possible reason for this difference I have been struck by a noteworthy difference in the terminations of the respective veins.

First, the saphena magna at its termination is covered only by a yielding superficial fascia second about one fourth of all individuals are born without any valve lying above the saphenous termination even to the right auricle (6-13). The dilatation of the vein involves also its terminal part as it enters the femoral. Frequently, this is so marked as to cause a good sized bulb at the fossa ovalis. In these dilated cases (such as have been under discussion as candidates for ligation) there is a very free flow into the saphenous from the femoral vein. Every sudden change in pressure as after coughing or straining is immediately imparted to the entire saphenous vein without any considerable reduction.

When we consider the lesser saphenous vein the termination is altogether different. First the vein runs beneath the deep fascia for some distance before it enters the popliteal or one of the tibial veins. Lying within the unyielding cylinder of deep fascia, this portion escapes dilatation (Fig 12). Second the popliteal and femoral veins above the entrance to the lesser saphenous contain about six to ten valves.

In instances therefore of varices of the lesser saphenous sudden increases in pressure in the

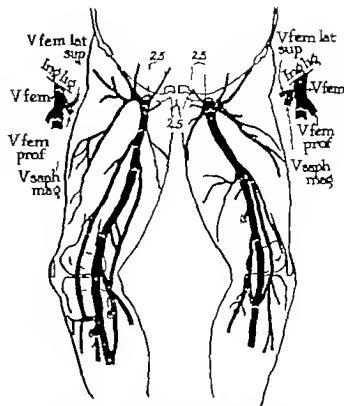


Fig. 10. Dissection of the great saphenous vein in the thigh. Valves are indicated in white. Insets show detail of valve arrangement at the saphenofemoral junction.

deep veins occasioned as noted by coughing or straining will result in a slowly rising pressure from resistance to flow of the blood in the vena cava and heart but the sudden downward shock of refluxed blood will be prevented. Again the narrow undilated part of the vein will still further dampen even the slowly rising pressure by its small size and by its valves in the deep part when they exist. This thesis is being investigated in more detail and will be reported fully later.

PRESENT CLINICAL CRITERIA FOR TREATMENT

I shall here briefly note our criteria for the type of treatment to be used in any given case of varices as used at present in the Circulatory Clinic at the Boston City Hospital. I am indebted to Dr. Lawrence McCarthy of that clinic who shared with me the responsibility of arriving at the criteria.

We try to determine, at the first visit of the patient

- 1 The actual presence of varices and whether they occur in the distribution of the greater or lesser saphenous

- 2 The condition of the great saphenous vein and whether there is a positive Trendelenburg test.

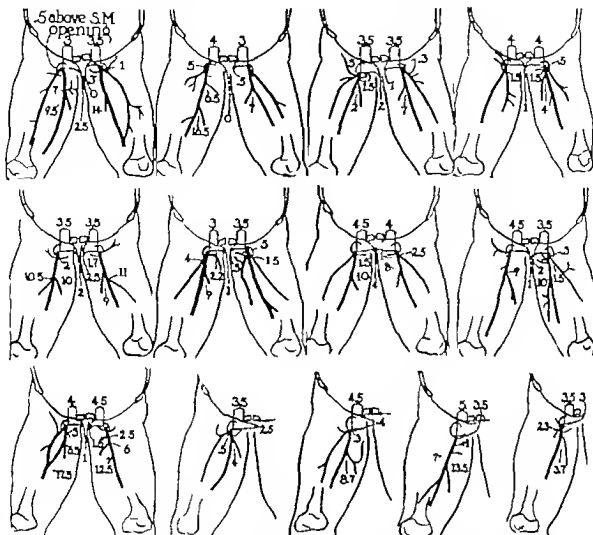


Fig. Terminations of the great saphenous vein—from classroom dissections.

3 The condition of the valves of the perforating veins

4 The condition of the deep veins.

We then proceed with our treatment

1 If the varices are limited to the distribution of the lesser saphenous vein, we use the injection treatment alone. The solutions we use are (a) quinine urethane for the small or medium sized varices (b) 20 per cent sodium chloride for the large varices (c) 5 per cent sodium morrhuate for aneurysms (in private practice I prefer this solution in all cases)

2 If the varices are in the distribution of the great saphenous vein but the vein is not widened and the Trendelenburg test is negative we use the injection treatment alone. If the Trendelen-

burg test is positive we send the patient into the hospital for ligation at the saphenofemoral junction inject the distal segment with varicoid (invert sugar and sodium chloride) then follow up in the out patient department with injections as in the cases with negative Trendelenburg tests.

3 If the Trendelenburg test is doubly positive we ligate the saphenous, excise the incompetent perforation and inject the remainder in the out patient department. These cases are relatively uncommon.

4 In cases of obliteration of deep veins, it is a good rule not to disturb the superficial varices. We have injected the varices in the lower leg in a case of occlusion of the inferior vena cava, with much improvement. In this case however the

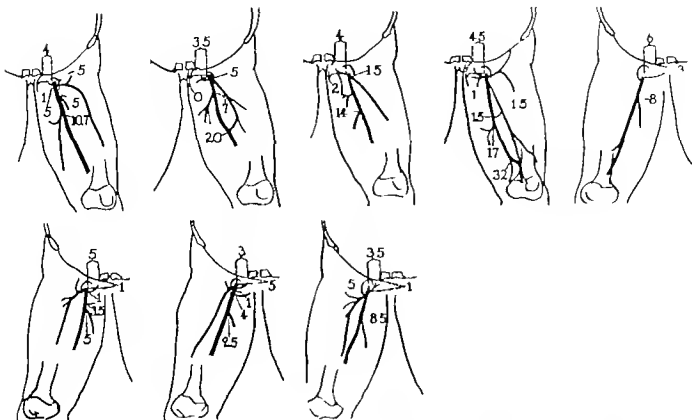


Fig. 11

original deep phlebitis had not involved the deep veins of the leg proper.

5 Patients with ulcer we treat according to the criteria laid down above, but we inject very cautiously, staying far away from the ulcer until it is free from infection, sometimes not injecting until we have first reduced the inflammation by ligation alone, or by supportive dressings. We have never found it necessary to excise an ulcer. If there is an incompetent perforator beneath the ulcer, we believe the ulcer can be temporarily healed by ligation and injection. The perforator can then be excised several weeks after the ulcer is healed.

6 Patients with phlebitis are treated as are patients with ulcer. The progress of the phlebitis is stopped by the ligation or small injections far from the phlebitic focus.

SUMMARY AND CONCLUSIONS

The injection treatment alone has failed to cure permanently those cases of varicose veins with concomitant dilatation of the great saphenous vein. The failures have been due to (1) recanalization of the sclerosed segments, and or (2) dilatation of previously existing normal collaterals.

Reports of others and our experience at the Boston City Hospital indicate so far that a

preliminary ligation of the great saphenous vein will protect the subsequently injected veins from recurrence by the above processes.



Fig. 12. Venogram of a varicose lesser saphenous vein. The termination of the vein beneath the deep fascia is well shown.

Ligation of the saphenous vein with or without subsequent injection may fail because of the reformation of the parent trunk or the varices through widening of collaterals and tributaries of the saphenous. Anatomical studies here reported, affirm the contention of Homans of 1916 that the proper site for ligation is at the saphenofemoral junction. It is only at this point that one can surely be above the origin of all the tributaries and collaterals of the saphenous vein.

The site of the saphenofemoral junction does not vary greatly in different individuals. Its average location may be found at a spot 3.9 centimeters lateral to and 1.7 centimeters below the level of the pubic tubercle. Being a bony point, the tubercle is probably the most reliable landmark for the localization of the site. On the operating table it would seem that a good rule would be to place the incision 1.7 centimeters below the level of the pubic tubercle and 1 centimeter medial to pulsation of femoral artery.

Clinical results reported from the Massachusetts General Hospital and our results at the Boston City Hospital indicate that when the ligation is carried out at the above site and all the terminal tributaries are secured, few subsequent injections are needed the varices disappear quickly and do not recur. The cases chosen for this procedure are those with widening of the great saphenous vein and loss of valve function in that vein. Patients without this dilatation of the saphena magna are treated by injection alone.

Varices of the lesser saphenous probably never have to be treated by ligation of the parent trunk. The difference apparently lies in the fact that the lesser saphenous terminates in a fine vein running beneath the deep fascia. Here it empties into a vein which is well valved. Thus sudden rises of venous pressure traveling centrifugally are dampened and unperturbed but slightly and without great momentum of the blood mass, to the surface veins.

I am greatly indebted to Dr. Timothy Leary and Dr. John Homans for helpful criticism.

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THE ROENTGENOLOGICAL DIAGNOSIS OF MECKEL'S DIVERTICULUM¹

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ACCORDING to Gray's *Anatomy* Meckel's diverticulum consists of a pouch which projects from the lower part of the ileum in about 2 per cent of subjects. Its average position is about 1 meter above the ileocolic valve and its average length about 5 centimeters. Its caliber is generally similar to that of the ileum and its blind extremity may be free or may be connected with the abdominal wall or with some other portion of the intestine by a fibrous band. It represents the remains of the proximal part of the vitelline duct, the duct of communication between the yolk sac and the primitive digestive tube in early fetal life.

Ray Shannon in the *Archives of Pediatrics* December, 1928 says 'According to Fitz in the newborn it lies about 12 inches above the ileocolic valve while in the adult, this is increased to about 3 feet. The diverticulum may be long or short, may or may not have a separate mesentery or may be contained within the mesentery of the small bowel. It may be fixed at its distal extremity to the umbilicus or to any structure within the abdominal cavity. It is often conical in shape with the base large, even approaching in size the diameter of the small bowel at this point. According to Christopher it usually has the same coats as the intestine, the mucous coat containing Lieberkuhn's gland and Peyer's patches. This same writer quotes Aschoff as saying that it may contain gastric glands, ciliated epithelium, and even pancreatic anlage. A certain number of Meckel's diverticula are associated with deformity at the umbilicus and marked deformity of the navel should therefore always bring to mind this possibility.

According to Vaughan and Singer Elements of gastric, nodular and colonic character also glandular tissue or pancreatic and tissue of questionable origin may be found within the walls of the diverticulum. Of these the heterotopic structures gastric mucosa is of greatest clinical importance since such secretions here as in the stomach have the ability to digest the intestinal mucosa, and muscularis, and lead to the formation of peptic ulcer. Mucous membrane of the gastric type is found according to Koch in 12 per cent and according to Schetz in 16.6 per cent of the cases of Meckel's diverticulum. As with peptic ulcers of the stomach and duodenum those of Meckel's diverticu-

lum are subject to hemorrhage, and acute perforation.

Symptoms of Meckel's diverticulum The fact that this condition exists in about 2 per cent of all individuals, and very commonly is found at autopsy without having produced any symptoms indicates that, unless some pathological condition develops in the diverticulum there are not likely to be any symptoms. The symptoms will vary according to the nature of the pathology present. The diverticulum may become inflamed just as any other part of the gastro-intestinal tract may become inflamed. If so it may become attached by adhesions to various parts of the abdomen or any other part of the intestinal tract, and therefore may give rise to some mechanical distortion of the small or large intestines.

In children the symptoms more often resemble an acute appendicitis, especially when perforation has taken place, even when localized as in the case by Moolton than anything else and if the diagnosis of appendicitis is eliminated, then the second thought must be an inflamed Meckel's diverticulum. Inflammation may take place and cause a fibrosis at the base with partial or complete occlusion of the bowel. The tip of the diverticulum may become attached to the umbilicus or another viscus strangulation or torsion of the adjacent small intestine can occur and produce intestinal obstruction. Intussusception can occur from the invagination of the diverticulum. An ulcer may form and give the acute symptoms of intestinal perforation.

The most frequent symptom however is hemorrhage from the bowel. When this occurs in a child it must make one think first of a Meckel's diverticulum. Vaughan and Singer state Symptoms referable to the diverticular ulcer prior to perforation are with the exception of hemorrhage seldom noted. The occurrence of sudden, violent pain beginning generally in the lower half of the abdomen followed almost immediately by the symptoms and signs of a diffuse peritonitis is characteristic of a perforated ulcer. When the patient is a child the likelihood is still greater that the ulcer is located in Meckel's diverticulum. There may be an abdominal pain particularly before meals and relieved by food as reported by Megaw and Dunant, or rhythmic distress located in the right lower quadrant such as occurred one and



Fig. 1. Examination made about an hour after giving the patient the barium mixture shows the diverticulum lying approximately over the shadow of the spinal column in the median line, approximately in the region of the umbilicus, and definitely involving the ileum. Notice the smooth outline, the large size, and the pear-shape. Case.



Fig. 2. The diverticulum with a longer stem, and a definite peristaltic action at the middle of the diverticulum. Case 1.

a half hours after meals in Kleinschmidt's case. Melena is probably the most important symptom since the children are too young to make complaint. There may at times be profuse hemorrhage. There may be at times abdominal cramps. In one of Shannon's cases there was slight bleeding then improvement in all symptoms, then signs of intussusception, a palpable mass, confirmed at operation but death in 8 hours. The patient of Dumitroff and Purkins complained at age of 28 of headache, vomiting and general indisposition. Tuberculosis may develop in Meckel's diverticulum as Michael records the ninth case of this complication in a white male aged 30 years. This has always been a part of a tuberculous enteritis or tuberculosis elsewhere, and in his case caused a constriction in the colon, which constriction in the transverse colon was recognized roentgenologically and was thought to be neoplastic. No diagnosis of Meckel's diverticulum was made.

The roentgen diagnosis. Preceding this report so far as I can find there is no definite record in the literature under the heading of Meckel's diverticulum diagnosed by means of the roentgen-rays, but by correspondence, I learn through my friend, Dr. James T. Case, that he has mentioned the diagnosis of this condition under the general heading of Jejunio-ileal diverticula, in which he says

Only rarely have we been able to make a diagnosis of Meckel's diverticulum with the X-ray study. In a number of instances we have discovered in the routine roentgen examination signs which we thought indicated conclusively the presence of a Meckel's diverticulum but the majority of these patients presented no symptoms indicating the need of operation and so it has happened that once only have we been able to find at operation a Meckel's diverticulum where a pre-operative roentgen examination has led us to make a correct pre-operative diagnosis." By letter he says, "The operation was done about 4 days after the ingestion of the barium and some barium was still in the diverticulum at the end of removal." The date of the diagnosis of this case has not been mentioned.

About 2 years ago, Kantor told me that he had not made any such observations, and that he knew of no one who had made such a diagnosis. I then promised to record my observations, but it has been postponed until the present time. Since then I have corresponded with LeWald, Hinch, Kirklin and Camp, and none of them has diagnosed a case of Meckel's diverticulum. Schintz, Baensch and Friedl in the third edition of their comprehensive and complete book, published in 1932 in two volumes on roentgenological diagnosis, make the statement that no such diagnosis has been made. Barclay in his recent book, 1933, does not mention the possibility of the diagnosis of a Meckel's diverticulum. In the *Roentgen Litera-*



Fig. 3. A wave of peristaltic contraction at the fundus pointing downward to the left, and another wave in the neck of the diverticulum. Case 1.



Fig. 4. The diverticulum more than half empty but still presenting smooth walls, as compared with the remainder of the bowel. Please notice that the other segments of the small intestines show progressive distribution of the barium mixture. This film has been made in the oblique position, which has thrown the diverticulum and the pyloric end of the stomach to the right of the spinal column. Case 1.

ture collected and edited by Dr. Hermann Gocht, and just published January 1934 makes no mention of the diagnosis of this condition. In the *Cumulative Index of 1933* I find no such diagnosis having been made. Therefore, it has seemed to me advisable to record the diagnosis which I made of 2 such cases, the first 1 having been made on February 3, 1923, or approximately 11 years ago and the second one having been made on February 2, 1931. Since presenting this material before the Philadelphia Roentgen Society on April 1, 1934, Dr. Wm. J. Corcoran demonstrated a lantern slide and referred to the case as reported by Dimitroff and Purkiss in which there was a distended loop of the ileum which led to the diagnosis and operation for Meckel's diverticulum.

CASE 1. The first case was referred to me by the late Dr. Robert P. Cummins. The child was a male $7\frac{1}{2}$ months of age. Three weeks before coming to my office the patient had had two hemorrhages from the rectum within 15 minutes. The patient was placed in the Germantown Hospital for study during a period of 1 week. During this time the patient was seen by Drs. Charles A. Fife and Charles F. Mitchell, who could find no explanation of the hemorrhage from the bowel. A ray study was made but nothing abnormal was detected. However, because of the fact that the parents had lost a child 1 year of age, who died of a perforating Meckel's diverticulum 13½ years previously on the operating table, Dr. Cummins brought the patient to my office for study. I gave the patient a mixture of barium and then watched the small intestines especially. I kept the patient in my office the whole day and then for an additional half day and made repeated examinations so as to catch the movement of the contents of the small bowel in every segment. On the first day, about a half hour after a barium meal and with the child in the prone position, I

found in a series of films made by instantaneous exposure, a pear-shaped body approximately 4 centimeters in length with the base directed downward and to the right and the stem upward and inward. This I believed to be a diverticulum. It was only shown when the patient was lying on the abdomen. I concluded, therefore, that the base of the pear-shaped body or diverticulum was located anteriorly so that when lying prone, gravity carried the contents of the intestines into this diverticulum and when the patient was lying on the back or sides, it emptied itself and could not be shown. This diverticulum showed evidence of peristaltic contractions and, as is shown in the illustrations, the shape changed continuously. These exposures were made instantaneously and therefore, the lines are quite sharp but there was a continuous movement. Of special interest also, this diverticulum seemed to hold a fixed position while all the other parts of the small intestines showed the usual shifting movements.

I repeated the examination on the second day in order to get confirmation but on the second day I was unable to make this demonstration, probably because the diverticulum may have been filled with some other non-opaque material. I recommended operation, which was performed by Dr. Mitchell in the presence of Drs. Fife and Cummins. The following report which has been furnished to me by the surgeon, Dr. Charles F. Mitchell, is transcribed from the records of the Germantown Hospital and will give the details concerning the operation.

The patient was brought to me because of hemorrhage from bowel.

On February 2, 1923, the child was given a dose of castor oil because of green stools and on the morning of February 3 at 5 o'clock began to cry as if in severe pain. When the mother reached its bed, there was found a large stool appearing to be mainly blood. About 10 o'clock that morning

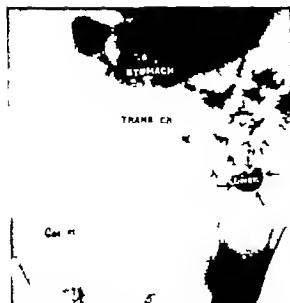


FIG. 5. The stomach is filled, and the bulbous duodenum well filled. Small quantities of the barium mixture are scattered through the small intestines, and the diverticulum is recognized on the left side of the abdomen. Please notice again the smooth outline, and sac-like formation. It is unquestionably involving the small intestine, and it seems that it could be nothing else but a diverticulum. Please notice that the ascending and transverse colon as well as the remainder of the small intestines are filled with gas. Case 2.

another sanguineous stool appeared but not so much as in the previous one. The child had had no previous illnesses.

One brother died at 1 year of age during an exploratory laparotomy following a second hemorrhage from the bowel, the hemorrhages being 3 months apart. Operation disclosed ruptured Meckel's diverticulum.

Physical examination revealed a well nourished, really overzest, white, male child. The skin and conjunctivae were normal. No glandular enlargements or deformities were present. The heart and lungs were negative. No tenderness was elicited anywhere over the body. The abdomen was naturally distended. Child was not nauseated. Treatment consisted in rest in bed, no food, plenty of water.

February 4, 1931, X-ray examination showed no evidence of foreign body in abdomen. Examination was made by fluoroscope and X-ray. February 7, 1931, the stools still showed some small amount of blood. The child was allowed to have whey and barley water. Condition was good. February 8, 1931, X-ray examination of stomach was negative. Barium did not reveal any abnormality of small intestine. The barium in ascending colon showed some spasticity. The barium passed very quickly through the small intestine as indicated by the fact that the small intestine was not outlined. I am unable to determine the cause for hemorrhage. H. H. Thiesell.

On February 10, 1931, child left the hospital in good condition.

On March 2, 1931, patient was again admitted to the hospital—after a diagnosis of diverticulum had been made. At time of present admission occult blood was present in stools. There was no history of any considerable

hemorrhage since previous admission. Remainder of his story and physical examination are as in previous history.

On March 3, examination of blood showed hemoglobin 73 per cent, red blood cells, 2,530,000, white blood cells, 7,400, neutrophils, 57 per cent, lymphocytes, 36, large myelocytes, 3, transitional, 9, coagulation time, 25½ minutes.

On the same day an exploratory operation and diverticulectomy was done by Dr. Mitchell, ether anesthesia being used. An incision was made through the right rectus muscle. The appendix while showing no signs of acute inflammation was much larger than ordinarily found in a very young child. There were no adhesions, the appendix being free. Eighteen inches from the ileocecal valve on the upper and anterior surface of the ileum, as found a diverticulum the base of which was 3½ inches in diameter of funnel shape, about 15½ inches long, the distal end attached to mesentery. It showed no indications of either acute or chronic inflammation. The diverticulum was ligated across its base, resected, and the stump covered with peritoneum. No exploration, except as stated above, was made of abdominal viscera. The incision was closed without drainage.

On March 11, examination for occult blood was positive.

On March 13, patient was discharged after recovery from operation in record time without complications. However, blood was still present in stools.

Pathologic report. The specimen consisted of small piece of intestine showing usual rugae. The specimen had been opened so I was unable to note any constrictions. The appendix was 65 millimeters long, had been opened, showed some slight external congestion, and had a thickened mucous membrane. Microscopic examination of the appendix showed numerous large lymph nodes. The mucosa was normal in thickness, showed low grade polymorphonuclear infiltration. The outer coats were normal. Diagnosis: acute catarrhal appendicitis (mild).

Section from low or bowel shows engorging of blood vessels and slight thickening of mucous coat, otherwise normal.

This child has had no symptoms since leaving the hospital and has grown up to be a fine healthy boy, now 11 years of age. It is of special interest that an X-ray examination made by a competent radiologist at the first admission to the hospital showed no evidence of any lesion of the small intestine. When examined by me 3 weeks later the diverticulum was clearly shown in the films. Because of the struggling child no satisfaction was obtained fluoroscopically and because of the history of hemorrhages, we tried not to use any force. I then repeated the examination on the following day but the diverticulum did not fill with the barium. This shows that an unusual amount of work and repetition may be necessary when a diverticulum is suspected.

CASE 3. A male child, aged 7 years, was brought to my office by Dr. Michael Margolies, February 2, 1931, at the advice of Dr. John B. Dow, the family physician being Dr. John B. Farrell. The boy had been complaining of pain in the umbilical region for 3 weeks, but these pains had not been severe until 3 days before coming for X-ray examination. He had vomited on each of the two preceding days. This vomiting occurred about 5 hours after taking food. He had been having one bowel movement daily. The stools were well formed. The pains were cramp-like in character.

but between the attacks of cramps, he was feeling well. He had no fever or chills. He had tenderness about the umbilical region and lower abdomen, but this tenderness was not constant. The cramps occurred 2 to 3 hours apart but had been so severe that they awakened him at night. There was no blood in the stools, and diet seemed to have no influence on the symptoms. Dr. Margolies suspected appendicitis. A roentgenogram of the general abdomen showed both kidneys present, normal in size, outline, and position and no evidence of stone in the kidneys, ureters, or bladder.

The liver was normal in size, outline, and position. The spleen was normal. The stomach was normal. The duodenum was normal.

Because of my suspicion that his pains were connected with his small intestines, I studied him frequently during a period of 6 hours, and I found a pocket of retained barium located 1 inch above the crest of the ileum in the left side of the abdomen which was pear-shaped, and had the appearances of a diverticulum. It showed very active peristaltic movements but at no time during my fluoroscopic observations was I able to see this sac empty itself. This did not apply to any other part of the small intestines, for elsewhere I was able to see the contents move normally. A sense of resistance and fullness was found just above the crest of the ilium. A diagnosis of Meckel's diverticulum was made. A barium enema showed nothing abnormal in the sigmoid flexure, or any part of the colon, and the colon emptied satisfactorily but this retention in the sac which I diagnosed as a Meckel's diverticulum remained even after the bowel was empty.

The appendix itself was not visualized, but the caecum was freely movable, and there was no localized tenderness about the caecum. I assumed that either the appendix was obliterated, or that it was so active that it did not retain the barium sufficient to be demonstrable. In my opinion, there was no evidence of any appendicitis. He was returned to the late Dr. John B. Denver's care, at the Lankenau Hospital for operation, but all pains and all symptoms disappeared after he reached the hospital. He was not operated upon and he has had no operation to the present day and no recurrence of the symptoms. At the hospital it was found that he had a moderate grade of secondary anemia, but normal leucocyte count, no abdominal distention, no rigidity and no tenderness.

This case resembles in every way the previous one, but evidently the symptoms have quieted down, and operation has not become necessary. The diagnosis of Meckel's diverticulum certainly should be a possibility in most instances if the condition is suspected and if sufficient, thorough and skillful work is done keeping in mind the anatomical conditions and the varying location and the varying pathology connected with Meckel's diverticulum. We must realize that a child or adult would have to be examined in every possible position to detect a Meckel's diverticulum for the base of the sac may be posteriorly, anteriorly, vertically upward or downward or at any other angle. It may be filled with non-opaque material which would prevent the entrance of the barium and therefore remain invisible. Therefore, unless the patient's small intestines are studied with this thought in mind, and in every possible angle, and probably by repeated examina-



Fig. 6. The stomach is empty and the ascending and first half of the transverse colon are filled with barium. The remainder of the barium is distributed through the terminal coils of the small intestines. The diverticulum still persists and retains its firm, smooth outline, as distinguished from the varying walls of the other small intestines. Case 5.

tions, such a diagnosis will not be made. It is a well known fact that the studies of the small intestines in general have been neglected. This effort to show Meckel's diverticulum may be the means of learning much else about the small intestines that has been overlooked. Some very excellent work has been done by the late Dr. Walter Mills, Dr. James T. Case and also by Dr. Lewis Gregory Cole and others, but in the great general mass of gastro-intestinal work, it has received less attention than any other part of the gastro-intestinal tract. The roentgenological characteristics of Meckel's diverticulum will of course be variable, but in general, they will have the characteristics that belong to any diverticulum. The diverticulum cannot be filled with a barium mixture if it is already filled with some other material. It is apt to show definite peristalsis. It is smooth in outline and it retains its position at a fixed point. The fact that a Meckel's diverticulum has been definitely diagnosed 10 years ago by means of the roentgen rays and again 3 years ago would indicate that it can be done again.

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END-RESULT STUDY OF HUMERAL SHAFT FRACTURES

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IN 1925 the fracture service of the Massachusetts General Hospital adopted the system of determining and recording end-results of treated cases which is now in force. Briefly the system consists of examining and roentgenographing each patient long enough after injury to warrant the assumption that no further changes will occur. The shortest period of observation is 1 year while some cases, notably those involving epiphyseal injuries, are followed for many years before the end-result is decided. Each case in which the final end-result is to be noted is discussed by several members of the fracture service, and an impartial rating is agreed upon for each of three components. These are *anatomical* (based on clinical and X-ray appearance), *functional* (based on strength, presence or absence of pain and limitation of motion) and *economic* (based on comparative earning capacity before and after injury). Each of these three aspects of the end-result is graded either 1, 2, 3, or 4 according to the 25 per cent group into which it falls from zero per cent to 100 per cent of theoretical perfection.

The present study is based on the fractures of the humeral shaft treated between 1925 and 1931 and now properly graded as to end-result. By shaft is meant only that portion of the humerus between the surgical neck and the flare of the condyles; thus fractures through the surgical neck and supracondylar fractures are excluded. Pathological fractures will also be considered outside the scope of the present study.

There were 82 fractures of the shaft of the humerus in the 7 year period investigated, and these constituted 40 per cent of all fractures of the humerus treated. The age distribution of these 82

patients was not distinctive. The ratio of males to females was about 2 to 1. The ratio of right to left humerus was about 4 to 3. The general distribution as to type and location of fracture is shown in Table I.

TABLE I.—TYPE AND LOCATION OF 82 FRACTURES OF THE HUMERAL SHAFT

Sex		Total
Males	Upper third of shaft	29
	Middle third of shaft	1
	Lower third of shaft	21
Type	Transverse fracture line predominant	30
	Oblique fracture line predominant	52

Of the 82 cases already mentioned only 41 are graded as to end result and hence available for critical review. It must not be thought that these have been selected for the quality of their results, as such a selection would have defeated the purpose of the study which is to evaluate the routine methods of treatment now in use. Due to the necessary omission of 18 patients treated in the emergency ward and consequently not graded as to end result, cases presumably of the simplest type, and also due to the presence of cases of patients unsuccessfully treated elsewhere and sent to us months after injury, the results here reported are probably not good enough to be representative of an entirely unselected group.

TREATMENT

The 41 cases in this series fall conveniently into 5 groups according to the method by which reduction and union were actually accomplished. It is understood that the treatment of no 2 cases can be exactly alike, so that these divisions are

TABLE II—THREE UNREDUCED CASES

Case	Age	Type of fracture	Site	Apparatus	End-results
1	8	Simple comminuted	Upper	Auxiliary pad and swathe	Died—pneumonia
2	60	Simple comminuted	Upper	Sling	AsF E4
3	7	Simple spiral	Middle and lower	Moulded plaster posterior splint	AsF E4

TABLE III—EIGHT CASES REDUCED BY MANIPULATION

Case	Age	Type of fracture	Site	Apparatus and time	End results
4	80	Compound transverse	Middle	Debridement, coaptation and sling to 7 wks	AsF E4
5	9	Simple spiral (old)	Middle	Plaster after-care slings here	AsF E4
6	30	Simple oblique	Middle and lower	Coaptation and swathe then plaster to 8 wks	AsF E4
7	4	Simple oblique	Upper	Plaster to 4 wks	AsF E4
8	6	Simple transverse	Upper	Sling and swathe to 6 wks	AsF E4
9	73	Simple comminuted	Upper and middle	Plaster to 9 wks	AsF E4
	65	Simple spiral	Lower	Moulded plaster time unknown	AsF E4
11	23	Simple transverse	Lower	Treated elsewhere. Entered M. G. H. for radial nerve paralysis	AsF E4

intended only to indicate related groups and are not to be taken literally.

1 *Fixation only* It will be seen from Table II that in Case 1 death occurred before an end result could be obtained. It is nevertheless included as a reminder that the patient's general condition may be more important than any attempt at reduction of his fracture. In this instance the patient died in spite of the very good judgment shown in doing nothing to the fracture beyond immobilizing it. One other fatal case will be mentioned later on in which the opposite policy led to disaster. Case 2 a diabetic, also was considered too ill for reduction and was consequently left alone. She recovered, and although the position in which the fragments united was not perfect she was able to do her housework as well as before.

It has been our experience that these extensively comminuted fractures of the upper third in old people result surprisingly well when treated only by the simplest methods of immobilization provided care is taken to prevent stiffening of elbow and shoulder joints. Many of them are already impacted in fair alignment and failure to unite is almost unknown.

Case 3 a little boy, presented a very different problem. This was a long spiral fracture with very little apparent displacement. No reduction or traction seemed necessary. Yet he failed to get a perfect anatomical result through the development of a varus deformity with loss of carrying angle at the elbow. One is tempted to speculate as to whether this would have happened if the arm

had been treated by traction during the 2 weeks that he was in the hospital.

2 *Manipulative reduction and external fixation* In the next group of cases reduction and union were accomplished by manipulation and external fixation alone, as shown in Table III.

Of course, this method was used in many more than 8 cases but Table III does not include those in which manipulation was a complete failure so that some other method had to be resorted to, nor the cases in which fluoroscopic manipulation was used only as an adjunct to constant traction or operative reduction. In addition most of the 18 cases treated in the emergency ward and consequently omitted here, were simply manipulated and put up in external fixation. Thus this group of 8 cases does not at all represent the true importance of this time honored method of treatment.

Only one of the 3 relatively poor results shown in Table III calls for any particular comment. In Case 6 the patient, a house painter was unruly and unco-operative because of a concomitant head injury which for several days made his fracture of secondary importance. All of the closed methods attempted during this time failed to maintain satisfactory reduction. One month after injury he was discharged in a plaster spica which was worn for another month. Sixteen months after injury there was firm union but with considerable deformity and limitation of elbow motion. In this case the result would probably have been better if an open reduction had been done as soon as the symptoms of concussion subsided.

TABLE IV—FIVE CASES REDUCED BY AMBULATORY TRACTION

Case	Age	Type of fracture	Site	Apparatus and time	End results
33		Simple oblique	Middle 1/3	Jones 4 in then plaster	AuFeE ₄
40		Simple spiral	Middle 1/3	Jones 4 in then plaster	AuFeE ₄
14	3	Simple spiral	Middle and lower	Modified Jones 4 in then sling	AuFeE ₄
5	4	Simple oblique	Upper and middle 1/3	Jones less than 3 in then sling	AuFeE ₄
16	8	Simple oblique comminuted	Upper and middle 1/3	Jones 4 in then castation and sling	AuFeE ₄

In Case 11 patient was treated elsewhere, only entering the hospital 2 months after injury for symptoms of radial nerve paralysis. In Case 5 patient was an epileptic idiotic child who was brought in 10 days after injury put up in plaster and immediately returned to the state school, where after treatment was carried out.

It is our feeling that this method is at its best in transverse fractures in which end-to-end apposition gives a stable reduction which will not slip during the application of plaster or other external fixation. It is certainly not suited to all types of shaft fractures.

Inherent in the use of primary plaster fixation is the tendency to overlong immobilization of joints, resulting in prolonged disability for the patient. In those types of fracture where non union rarely has to be considered, this constitutes a strong objection to the method. In those types where non-union is very common however namely the transverse fractures of the middle and lower thirds of the shaft, solid union in good position is the first consideration and the long fixation and consequent difficulty of restoring joint motion must be accepted as a necessary part of treatment. It is for this reason that immediate open reduction of such fractures finds favor with many surgeons.

3. Ambulatory traction. Most of the oblique fractures in our series required constant traction to secure and maintain reduction. Though constant traction is always more effective with the patient in bed, there were certain cases in which ambulatory traction proved effective enough for all practical purposes. These cases are listed in Table IV.

In Table IV it will be seen that the Jones ambulatory splint was used in each case with skin traction exerted by means of rubber tubing. In 2 cases the position secured by one day's traction was so good that a more convenient apparatus could safely be substituted. In the 3 other cases the Jones splint was worn until union occurred. All 5 had good end results.

The desirability of some form of ambulatory treatment for the 82 year old man requires no comment. The 2 children would undoubtedly

have done well with almost any method of treatment. The 2 adults, however are instructive because of the great difference in the length of their disability. In reviewing these 5 cases it seems apparent that the prolonged disability in Case 12 was due to the prolonged immobilization, and that much time was saved by the alert management in Case 13.

Case 12. Male, age 32, oblique, middle third. Ambulatory traction 25 days, plaster to 9 weeks.

Case 13. Male age 40, spiral, middle third. Ambulatory traction 1 day plaster to 3 weeks, then internal angular splint, castation splint and sling up to 7 weeks. Solid union and good function.

Solid union and poor function, 12 physiotherapy treatments.

Disability 8 months
End-result AuFeE₄

Disability 7 weeks
End-result AuFeE₄

It is worth noting that with one exception (Case 40) ambulatory traction was never attempted in a transverse fracture. We feel that constant traction is so dangerous in transverse fractures of the mid shaft, because of non-union, that if used at all it must be carefully controlled with the patient in bed, and that the ambulatory method with its comparatively crude traction is entirely unsuited to cases of this type.

4. Bed traction. The largest number of patients in the present series, as shown in Table V were treated by constant traction in bed.

All but 5 of the cases in this group were essentially oblique fractures, in which the danger of overriding was much greater than the danger of non-union. Having said so much about the danger of constant traction in transverse fractures of the mid-shaft, it seems necessary to offer some comment on the five transverse fractures in this group all but one of which united.

Case 17 was in the upper third and was compound. The reduction accomplished by fluoroscopic manipulation was unstable. Internal fixation was not considered wise, since the wound was 24 hours old when first seen. The reduction could be maintained with 3 pounds traction, and there

TABLE V—REDUCED BY BED TRACTION 15 CASES

Case	Age	Fracture	Site	Time in bed traction	End-results
7	4	Compound transverse	Upper $\frac{1}{2}$	About 3 wks	AaFaEa
18	41	Simple oblique comminuted	Middle and lower $\frac{1}{2}$	4 wks then plaster	AaFaEa
9	51	Simple oblique comminuted	Upper $\frac{1}{2}$	6 wks then plaster	AaFaEa
20	57	Simple oblique	Middle $\frac{1}{2}$	3 wks then ambulatory traction	AaF Ea
11	40	Simple transverse comminuted	Middle $\frac{1}{2}$	2 $\frac{1}{2}$ wks then ambulatory traction then plaster	AaFaEa
12	15	Simple oblique	Middle and lower $\frac{1}{2}$	1 wk then coaptation and sling	AaFaEa
3	4 $\frac{1}{2}$	Simple transverse	Middle $\frac{1}{2}$	6 wks then sling and swathe	AaFaEa
14	26	Compound transverse	Middle $\frac{1}{2}$	DeBordens and Kirschner wire	Died sepsis
1		Simple oblique comminuted	Lower $\frac{1}{2}$	1 wk ambulatory traction 2 wks molded plaster	AaFaEa
24	6	Simple transverse	Upper $\frac{1}{2}$	1 wk then plaster	AaFaEa
27	11	Simple spiral	Upper and middle $\frac{1}{2}$	3 wks then coaptation and sling	AaF Ea
28	61	Simple comminuted	Upper $\frac{1}{2}$	3 wks then coaptation and sling	AaFaEa
29	70	Simple comminuted	Upper $\frac{1}{2}$	1 wk then plaster	AaFaEa
30	11	Simple oblique	Middle $\frac{1}{2}$	1 wk then auxiliary triangle and sling	AaFaEa
3	6	Simple spiral	Lower $\frac{1}{2}$	1 wk then internal angular and sling	AaFaEa

was the further advantage that the wound could be readily exposed and dressed.

In Case 21 fracture could not be held reduced without traction. After 3 $\frac{1}{2}$ weeks in bed traction, followed by a few days of very unsatisfactory ambulatory traction patient was put into a plaster jacket. Two and one-half months after injury there was no evidence of union. Plaster cast was worn up to 3 $\frac{1}{2}$ months, when union was solid but function was poor. The patient returned to work as a tailor 6 months after injury and still lacked 10 degrees of elbow extension 14 months after injury. Open reduction in the first place would probably have been better.

In Case 23 patient was a 4 $\frac{1}{2}$ year old child with an unstable reduction. Non-union was considered unlikely at this age, so operation was not done, and union was solid 6 weeks after injury.

Case 26, a 6 year old child presented a similar situation. There was perfect position and good callus after 2 weeks in gentle traction. This was protected by plaster up to 3 weeks when the patient was discharged with only a sling.

In Case 24 patient died, but it is included for the same reason that Case 1 was included. He was a sailor whose arm was caught in a power windlass at sea, and on admission 24 hours after injury, the arm was described as a bag of bones. Unfortunately, every effort was concentrated on saving the arm. To secure alignment and at the same time allow for frequent Dakin's dressings, the arm was suspended by a Kirschner wire through the lower radius and ulna. Six days after injury multiple incisions were made in an attempt to drain a fulminating sepsis. X rays at this time showed excellent position of the fracture. Three days later the patient died of staphylococcus septicaemia. In this case it is obvious that the fracture was treated at the expense of the patient's life. Amputation should have been done.

Skeletal traction is practically never necessary in humeral shaft fractures, since 5 to 10 pounds usually suffices, and this amount of traction can always be applied through adhesive plaster attached to the skin. Although traction transmitted through the elbow joint is in general undesirable, it was several times employed in preference to skeletal traction or open operation in cases of oblique fracture low in the shaft. Under these circumstances, traction was kept up only long enough to make slipping unlikely (1 or 2 weeks) when some form of external fixation was substituted with the elbow at a right angle.

The devices most often used for bed traction were the Thomas arm splint and Blake's suspension, usually with the arm in abduction elbow at a right angle, and forearm suspended vertically. The average time in bed was 2.7 weeks. During this time the position of the fragments was checked by portable X-ray pictures, and if necessary corrected by manipulation. Motion of the shoulder and elbow joints within the limits of pain was usually encouraged from the start, with the idea of shortening the functional disability.

There were 2 comparatively poor end results which deserve a word of comment. In Case 19 the fracture was complicated by radial nerve paralysis necessitating operation 5 weeks after

TABLE VI—FIVE OPEN REDUCTIONS DONE BECAUSE OF FAILURE OF CLOSED METHODS

Case	Age	Fracture	Site	Original treatment	No. of operative reductions	Months of disability	End-result
31	26	Oblique comminuted	Lower 1/2	Bed traction and fluoroscopic manipulation		8	Ax.Pt.Es
32	26	Transverse	Middle 1/2	Bed traction and manipulation		7	Ax.Pt.Es
34	23	Oblique comminuted	Lower 1/2	Ambulatory traction		3	Ax.Pt.Es
35	6	Transverse	Lower 1/2	Fluoroscopic manipulation		About 3	Ax.Pt.Es
36	48	Transverse comminuted	Middle 1/2	Bed traction		4	Ax.Pt.Es

injury and interfering with the normal recovery of function. In Case 20 a concurrent head injury complicated the treatment of the fracture enough to prevent a perfect anatomical result. Neither of these partial failures can be attributed to the method of treatment employed.

It is our feeling that this type of treatment is at its best in oblique fractures where the contact of large surfaces of broken bone makes non union unlikely where strong muscle pulls would, if not counteracted produce overriding, and where no contra indication exists for putting the patient to bed.

5. *Open reduction.* The 10 cases which came to open reduction are shown in Tables VI and VII. They could equally well have been listed as failures under the various methods of closed reduction, but it has seemed more convenient to group them together since the discussion of some of them involves also the discussion of non-union.

In the cases in Table VI operation was not done for non-union, however, but for failure of satisfactory reduction by closed methods. Muscle interposed between the bone ends proved to be the obstacle to reduction in Case 31. At operation, 2 weeks after injury 2 Parham bands were applied. Daily elbow exercises were started 5 days later removing the anterior shell for the purpose. In spite of the Parham bands and the posterior plaster shell the fragments slipped badly so that the exercises had to be discontinued. There was then a tendency to delayed union, necessitating a long period of immobilization. Union was present 10 weeks after injury but the full range of motion never was regained. It is hardly fair to criticize the management of this case in the light of developments which could not, perhaps, have been foreseen, but in seeking to account for the comparatively poor result, we are forced to conclude that unnecessary delay in operation and inadequate fixation were probably the important factors.

In Case 33 it was at once apparent that bed traction was unsuccessful, and a bone plating operation was done 3 days after injury. Although

the eventual result was good, convalescence was prolonged by the development of an incomplete radial nerve paralysis.

In Case 34 fracture was reduced by open operation 7 days after injury and fixation was secured by a Parham band and plaster spica. The plaster was worn for 5 weeks and the patient returned to work as a chauffeur 3 months after injury with an excellent result.

In Case 35 patient was admitted 11 days after injury with beginning union in very bad position. Instead of operating at once, an attempt was made to improve the position by manipulation under the fluoroscope and external fixation. The improved position was not maintained, however and a bone plating operation had to be done 40 days after injury. The end result was excellent but the question may fairly be raised as to whether the loss of so much time before operation was warranted.

In Case 36 a severe head injury complicated recovery so that treatment of the fracture was of secondary importance at first. Bed traction was tried and would probably have succeeded, but the patient proved too unruly to co-operate, so 36 days after injury a bone plating operation was done. Operation was still further delayed by the presence of an axillary abscess. The eventual result was excellent.

Opinions differ widely as to the place of open reduction as a primary method of choice in fractures of the humeral shaft. When carried out under the most favorable conditions, the method undoubtedly has many advantages. Our own feeling however in view of the uniformly good results of closed reduction is that primary operation is seldom necessary. Perhaps the most striking fact brought out by a review of the end-results in the present series is that every patient, whatever his anatomical rating, was able to return to his former occupation. This makes us feel that the essential usefulness of the upper extremity is not entirely dependent on the presence of an anatomically perfect humeral shaft, and that the anatomical results obtained by closed methods of

TABLE VII.—TWELVE OPERATIONS DONE FOR NON-UNION IN 5 CASES

Case	Age	Fracture	Site	Original treatment	No. of operative reductions	Months of disability	End-result
37	30	Transverse	Middle $\frac{1}{3}$	Elsewhere		About 18	A ₂ F ₃ E ₄
38	31	Compound comminuted	Lower $\frac{1}{3}$	Elsewhere	1	About 26	A ₂ F ₃ E ₄
39	31	Transverse comminuted	Middle $\frac{1}{3}$	Elsewhere	1	33	A ₂ F ₃ E ₄
40	3	Transverse	Middle $\frac{1}{3}$	Ambulatory traction	3	21	A ₂ F ₃ E ₄
41	29	Compound comminuted	Lower $\frac{1}{3}$	operations elsewhere, 1 for non-union	3	40	A ₂ F ₃ E ₄

treatment are so good that such methods should usually be tried before resorting to open operation.

COMPLICATIONS

1. *Non-union and delayed union.* The 5 cases in Table VII represent frank non union and in several respects are the most important cases in the present series. Before discussing them in detail it is worth noting that they had certain points in common. It is significant, for example, that the patients were all young, healthy adults, in whom the processes of repair could not have been retarded by old age or disease. It would therefore, seem that age was definitely not a factor in the occurrence of non-union. Secondly all of the fractures were in the middle or lower third of the shaft, recognized as perhaps the commonest site of non union in the body. Furthermore 3 of the fractures were transverse, and reference to the X rays shows that in the 2 others the significant characteristic of a transverse fracture (from the point of view of repair) was also present, that is the lack of contact between broad surfaces of broken bone.

Case 37. Patient entered the hospital 9 months after injury with an ununited transverse fracture. At operation an inlay graft was used, with an osteoperiosteal graft wrapped around the site of fracture. This attempt was successful, and solid union promptly took place. The reason for the long delay before operation is not known.

In Case 38, patient also entered with an ununited fracture 9 months after injury and was operated on but in this instance a simple bone graft only was done. The postoperative position being unsatisfactory, another operative reduction was done 3 weeks later. Position was still unsatisfactory but rather than subject the patient to a third operation, it was corrected as well as possible by fluoroscopic manipulation and plaster was worn for 4 months. When the plaster was removed union was solid but function was naturally very poor. In spite of 99 physiotherapy treatments function never entirely came back, and 2½ years after injury the end-result was

A₂F₃E₄. A more radical operation preferably at a much earlier date might have obviated the delayed union with its consequent long immobilization and permanent impairment of joint motion.

Case 39 differs from the others in that non union followed the operation instead of preceding it. The patient entered 2½ months after injury, with solid union in very bad position. The position was corrected by osteotomy and held by a 4 screw Sherman bone plate. Union failed to take place, and 6 months later a bone graft was done elsewhere for non-union. Whether or not this particular failure should have been anticipated is a matter of opinion, but it is a fact that in our experience, bone plating often is not enough to produce union in transverse fractures of the mid humeral shaft, once the original reaction of repair has been allowed to subside.

Case 40 is the one in which patient was treated entirely on our own fracture service. Ambulatory traction was applied the day of injury and with the additional aid of fluoroscopic manipulation 3 days later, a perfect reduction was obtained. This was put up in an axillary triangle but 2 weeks later X ray pictures showed that the fragments had slipped. Ambulatory traction was again applied and patient was discharged, still in traction, 4 weeks after injury. As might perhaps have been expected, no union took place. Three operations were required to secure union, the best and last being a massive bone graft 14 months after injury. The 2 unsuccessful attempts were first, end stepping plus osteoperiosteal graft plus Farham band and second, osteoperiosteal graft plus solid inlay graft. Solid union resulted from this operation but later there was refracture, probably from absorption of the graft and another operation became necessary. The end result was good, but with a loss of 21 months. It is probable that any one of these operations would have succeeded had it been done at the time the first reduction was lost, while the fracture was still comparatively fresh.

In Case 41 there was ample cause for non union before coming under our care 14 months after

TABLE VIII—FOUR CASES OF RADIAL NERVE INJURY

Case	Fracture	Sets	Onset after injury	Onset after operation	Treatment	Recovery
	Transverse	Lower $\frac{1}{2}$	4 wks.		Cock-up and physiotherapy	Complete
28	Oblique comminuted	Upper $\frac{1}{2}$		day	Nerve transplanted	Union complete
33	Comminuted transverse comminuted	Lower $\frac{1}{2}$		Elsewhere	Elsewhere	Complete
39	Transverse	Middle $\frac{1}{2}$		4 days	Nerv. anastom.	Practically complete

injury. Originally a comminuted compound fracture, it had been treated by immediate débridement and removal of the loose fragments of bone. Three months later a bone graft had been done for non-union, but it had become septic and sloughed out. Consequently on admission there was a gap of $1\frac{1}{2}$ inches between rounded eburnated, bone ends. Again 3 operations were required to secure union. The first was refreshing the bone ends and wrapping an osteoperiosteal graft around the fracture line. After 3 months in plaster there was no union. The second operation consisted of inlay plus osteoperiosteal graft, and this also failed to produce union. Five months later a massive onlay graft held in place by 4 steel screws, resulted in union. Following this operation the patient was given cod liver oil, milk, orange juice, calcium lactate and daily quartz lamp treatment. She resumed work as a book keeper 3 years and 1 month after injury with a permanent impairment of elbow function. Had the last operation been done in the first place, there is every reason to suppose that nothing further would have been needed.

It is perhaps unnecessary to labor the point which these cases demonstrate so clearly, namely that ordinary measures cannot be expected to meet the requirements of an extraordinary situation. Non union is common in transverse fractures of the mid-shaft. It is favored by sepsis, by lack of proper immobilization, and by anything which prevents close, continuous contact between the bone ends. When primary union fails to occur under the stimulus of the original reaction of repair then a situation exists which may be considered extraordinary and which demands drastic treatment both of the local lesion and of the patient as a whole.

Delayed union, that is, union which though it occurs spontaneously requires longer than the average time is of course impossible to distinguish from non-union until union begins to take place or until there is evidence that it never will take place. This may require from 3 to 6 months. In the present series of 41 cases there were 4 patients not operated upon who may be considered

to have shown delayed union. In 3 of them (Cases 19, 20 and 21) spontaneous union occurred at $2\frac{1}{2}$, 3 and $3\frac{1}{2}$ months, respectively. In Case 36 there was no evidence of union 5 weeks after injury and as the fracture was a transverse one in the middle third, it was felt that spontaneous union was extremely unlikely to occur and operation was accordingly done.

Taking the 5 cases in Table VII to be the only ones in which non-union occurred, as they certainly were in the 41 cases with graded end-results and probably were in the larger group of 82 treated patients, the incidence of non-union in this series may be considered to have been about 6 per cent. The incidence of delayed union cannot fairly be computed because of the lack of any generally accepted standard of normality. We feel that non union is the most serious danger in the treatment of fractures of the humeral shaft, that it is always an indication for operation, and that the most satisfactory operation probably is a massive onlay graft fixed by screws.

2. *Radial nerve injury.* Radial nerve injury the only other common complication, was encountered in 4 of our cases, with essentially complete recovery in all of them. This is an incidence of about 5 per cent in 82 fractures of the humeral shaft.

In Case 11 beginning paralysis was evident about 4 weeks after injury and recovered without operation.

In Case 28 signs of paralysis appeared the day after operation. Increasing for 5 weeks, when operation was done. Although the nerve was found intact, it was transplanted and recovery was almost complete only a little weakness of wrist extension remaining 1 year after injury.

In Case 33 wrist-drop developed following débridement and removal of bone fragments elsewhere. What treatment was given is not known but on admission 24 months after injury no evidence of paralysis remained.

In Case 39 a bone plating operation was done 3 days after injury and was followed 4 days later by radial nerve paralysis. The symptoms increased for 7 weeks, when operation was done. A

little scarring of the nerve was found, but no evidence of serious injury. Recovery was complete. We have seen transitory paralysis follow similar open reductions in which particular care was taken to isolate the radial nerve and keep it in sight throughout the operation. Apparently the slight stretching caused by retracting the nerve is often enough to produce symptoms of paralysis.

These cases, though the outcome was fortunate, do not illustrate the present policy of the fracture service with regard to radial nerve injury. It is agreed that immediate nerve symptoms suggest direct injury to the nerve and that symptoms coming on several weeks after injury suggest progressive involvement of the nerve by callus. We feel that delayed progressive paralysis usually demands exploration and transplantation of the nerve. On the other hand, mild symptoms immediately following injury practically never demand operation, since they are due merely to a bruising or stretching of the nerve, and tend to recover spontaneously. If, however, there is a progressive increase in the severity of the nerve symptoms, exploration should usually be done. With regard to immediate complete paralysis there is room for a reasonable difference of opinion. If this finding can be interpreted as due to an actual severance of the radial nerve, then immediate operation and anastomosis is desirable. If, however, it implies only a severe bruise or stretch, as is almost always the case, it would probably be wiser to wait 6 to 8 weeks for beginning signs of recovery.

In general it may be said that radial nerve injury though common, is a relatively benign complication since spontaneous recovery is the rule rather than the exception. It is highly desirable to recognize the rare case of traumatic nerve severance and repair it early. As long as any symptoms of radial nerve injury are present, a cock up splint should be worn and the extensor muscles kept in condition by physiotherapy.

The possibility of late radial nerve involvement should be thought of particularly in extensively comminuted fractures with wide displacement, as this consideration might occasionally influence the type of treatment. It seems reasonable to suppose that this complication would be less likely to appear the more accurate the reposition of the fragments.

SUMMARY OF END-RESULTS

Finally, leaving out of account all other considerations and taking the cases in this series just as they come complicated and uncomplicated, easy and difficult, well managed and not so well managed, we see in Table IX a recapitulation of

TABLE IX—SUMMARY OF END-RESULTS IN 41 CASES

Cases	
A ₁ F ₁ E ₁ —	28
A ₂ F ₁ E ₁ —	3
A ₃ F ₁ E ₁ —	3
} 80 per cent satisfactory	
A ₄ F ₁ E ₁ —	5
A ₅ F ₁ E ₁ —	5
Dead	2
} 80 per cent relatively unsatisfactory	

the end results, and, after all, the end result is the most important single criterion we have. No case was rated lower than 2 anatomically, 3 functionally or 4 economically. Compared with other regions of the body such results are remarkably good, so that even those which are referred to here as relatively unsatisfactory might not be considered unsatisfactory at all when compared with the results of fractures in general.

It is quite surprising to find that these end results were influenced so little by age, in fact, the results in the older age-group were actually better than those in the younger. Similarly, non-union in this series was seen only among young adults, often persisting in spite of repeated operations, while in marked contrast was Case 4, an 80 year old woman who got spontaneous union of a compound transverse fracture of the mid-shaft, with the bone ends projecting and the brachial artery and median nerve exposed after being discharged against advice on her twenty-eighth day with her arm in only coaptation splints and a sling!

The only other significant generality that emerges from an analysis of the end results is concerned with the type of treatment. The group treated as bed patients had better end results than those treated as ambulatory patients, in spite of the fact that the former group contained most of the difficult cases.

CONCLUSIONS

1. When intelligently treated by any suitable method the end results of fractures of the humeral shaft are excellent.

2. In general, transverse fractures should be reduced by manipulation (closed or open) and held by fixation (external or internal). Oblique fractures should be reduced and held by constant traction and comminuted fractures should be treated by the simplest method suited to the individual case.

3. Constant traction is dangerous in transverse or short oblique fractures, especially where they occur in the middle and lower thirds, and should be used only with great caution, if at all, under these circumstances.

4. Bed traction is always more effective than ambulatory traction, but is not always necessary. Ambulatory traction may be well applied by means of the Jones humerus splint and bed traction by means of the Thomas arm splint or Blake's suspension.

5. Primary open reduction as a treatment of choice, though sometimes desirable, is not often necessary. The indications for early operative reduction are (a) failure to accomplish or maintain satisfactory reduction by closed methods, and (b) anticipated non-union.

6. Bone plating alone will not bring about secondary union after the original reaction of repair has subsided, as it will in a fresh fracture. Bone grafting is usually necessary.

7. Persistent delayed and non-union is the greatest obstacle to the successful operative treatment of old ununited fractures. The patient should be given the maximum chance for union at the time the first operation is performed, by the use of a radical procedure combined with the vigorous employment of the various common systemic aids.

8. Non-union may reasonably be anticipated when in a transverse or short oblique fracture in the middle or lower third of the humeral shaft, there has been no contact between the bone ends during the early period of active reaction of repair (usually about two weeks).

9. Radial nerve injury rarely results in permanent disability.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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MODERN ANÆSTHESIA

SURGEONS have been so accustomed to look upon anæsthesia as but a minor part of the operative procedure that they must be watchful lest they fail to realize and to make use of the part modern anæsthesia is playing in recent surgical developments. Surgery during the last two decades has made extraordinary strides and, while it is still making gratifying progress, its early rate of progress has of necessity slowed down somewhat.

Anæsthesia and anæsthetists, starting from the time when there was no anæsthesia (not such a great number of years ago) and from the time when ether was the sole anæsthetic (but a few years ago), are at the present time in a state of rapid, practical and very gratifying advancement.

Having had an interest in anæsthesia for several years, and a close association with physicians whose entire time has been devoted to anæsthesia and its relation to surgery the part anæsthesia and anæsthetists have played, and are playing, in improving surgery and surgical results has been impressed upon me

I have also had the opportunity to realize and appreciate that through the field of anæsthesia and anæsthetists there still remains throughout this country and abroad an opportunity to improve surgical procedures greatly from the point of view of the patient's comfort and safety, the ease and facility with which the operation can be performed, and the end results as they relate to mortality as well as morbidity.

Lest this editorial be construed as an argument against the nurse anæsthetist, I wish to state that in my opinion nurse anæsthetists under experienced physician anæsthetists' supervision are not only desirable but necessary. Well trained nurse anæsthetists under the supervision of physician anæsthetists can and do give most satisfactory and safe inhalation anæsthesia and serve to maintain anæsthesia costs at lower levels, a point of no small importance to the patient, the hospital the surgeon and the progress of anæsthesia.

We have but to view the available types of anæsthesia and to mention some of their special advantages to realize how important this field is in a surgical procedure. We would not consider operating upon a patient with intrathoracic goiter without intratracheal anæsthesia, knowing as we do that delivery of a large thyroid tumor from the chest often produces tracheal obstruction, that if tracheotomy is necessary after the mediastinum has been opened a mediastinitis easily results, and that with intratracheal anæsthesia such an emergency cannot arise.

The department of chest surgery in this clinic definitely attributes its low mortality rate, particularly in thoracoplasty for tubercu

losis, at least in part to the fact that these patients are anesthetized with the hydrocarbon anesthetic cyclopropane to the fact that cyclopropane anesthetic mixture has an oxygen percentage of 90 in contradistinction to the nitrous oxide anesthetic mixture with an oxygen percentage of 9 and to ethylene anesthetic mixture with an oxygen percentage of but 15 and to the fact that even though these patients must lie on the one good lung it is possible with this anesthesia with its rich oxygen content to maintain the patients in this position with pink color and to keep them well oxygenated.

Averin permitting as it does the arrangement of the apparatus after the patient's return to his bed has been a real boon to the orthopedic surgeon as well as to the general surgeon.

We in general surgery feel very strongly that the employment of intratracheal ethylene anesthesia combined with regional infiltration of the abdominal wall with metycain has made subtotal and total gastrectomy safer and so more possible than when either or spinal anesthesia were employed.

No longer do we hear nor should there ever be heard any statement as "I use spinal anesthesia entirely." Spinal anesthesia, in experienced hands, has a real place even in abdominal surgery particularly in acute appendicitis and intestinal obstruction. In upper abdominal surgery it also has a place, particularly for the good risk patient and in the operation which will not take over an hour. It is not a desirable form of anesthesia for poor risk patients or for those needing long operations because of the surgeon's inclination to demand high levels of anesthesia and a length of anesthesia demanding large doses of the drug. Surgeons are sometimes unconscious of the disadvantages of these events. They are so delighted by the relaxation the

quietness, and the ease of exposure with spinal anesthesia, that they sometimes unwisely employ high and long spinal anesthesia, a method associated with serious drops in blood pressure and dangerous states of shock.

A variety of special types of anesthesia, of special advantage can be mentioned as advantageous in surgical procedures particularly the employment of sacral anesthesia in electrocoagulation of the prostate and operative cystoscopy cervical block in the operation for oesophageal diverticulum and the savings of gas in goiter operations with the carbon dioxide extraction apparatus. For example it is stated by our anesthetists that to do a goiter operation without the carbon dioxide extraction apparatus requires on the average, 85 gallons of ethylene and oxygen while with this apparatus but 15 gallons are required a saving of 70 gallons of gas per operation together with a distinctly better anesthesia. In the anesthesia of patients having goiter operations alone in our clinic, this arrangement saves us seventy thousand gallons of ethylene per year and gives a better anesthesia.

Individual surgeons, and hospitals with surgical services, who wish to keep in step with the progress of surgery must appreciate that it is advantageous to encourage a limited number of men in a community to interest themselves in and become expert with the various number of methods of anesthesia. Likewise surgeons must be willing to co-operate with these men in their development as anesthetists and in the employment and selection of new anesthetics in cases in which they would be helpful.

Good anesthesia costs more than poor or mediocre anesthesia, but a surgeon or a hospital acquiring the advantages of the modern developments in anesthesia will very soon appreciate that they have been more

than repaid for the investment in terms of the patients' satisfaction, mortality, morbidity and the surgeons' and hospitals' comfort of conscience

FRANK H. LAHEY

PREPAYMENT PLAN FOR MEDICAL AND HOSPITAL SERVICE

PREPAYMENT plan for medical care for those falling in the moderate income group is one of the problems calling for most careful study by the entire profession and all its organizations. Canada and the United States are both confronted with the question. Help is being urgently demanded by the people and by civic and philanthropic organizations. The question is rapidly assuming national importance in both countries and unless the profession approaches the problem in a prompt and constructive manner poorly judged plans will be forced upon the practitioners of medicine. We should all have an open mind until some solution has been arrived at that is satisfactory to both the profession and the public.

Dr. Greenough in his presidential address at the recent meeting of the American College of Surgeons in Boston, turned his attention to this vexing problem. The full text of his remarks will appear in a later issue of the Journal. Meanwhile, we may quote his well balanced conclusions:

No single health insurance plan of national scope appears at present to be applicable to the conditions existing in this country. The matter is at present one for local study and experiment, in which the best medical and surgical ability in the community is needed acting in co-operation with others qualified by their knowledge of economic conditions to join in the study of the problem.

Individuals of the lower level income classes

in the moderate means group, for whom some support derived from the community to supplement any possible prepayment insurance plan may possibly be needed, are the ones for whom the provision of efficient medical and surgical service offers at this time the greatest difficulties. With further progress in health education those in the upper level of the moderate means class may well develop an interest and a desire to participate in voluntary prepayment plans beginning first with hospitalization alone, and extending ultimately perhaps to full medical, dental, and nursing services.

It is greatly to be desired that the trial of these new methods of providing medical and surgical service to the community should be encouraged in different communities where the co-operation of the hospitals, the medical profession, and others interested in the maintenance of the public health can be secured. Certain general principles which should be observed in the organization and operation of these plans have already been approved by the College. The hospital department of the College provides a ready means of securing accurate information in regard to these plans and their operation which should continue to be utilized to accumulate facts on which future judgment may be based.

While the advantages and disadvantages of the different plans for health insurance are under investigation in this laboratory of experience, a number of other steps are immediately open to us which should be of material help in providing more efficient service.

- 1 The value of the code of ethics of the medical profession in the protection of the interests of the whole population must be more widely appreciated by the public.

- 2 The medical and surgical care of the indigent sick must be recognized everywhere as an obligation of the community.

3 The segregation of hospital wards for patients of moderate means who can and should pay minimum hospital expenses and reduced fees should be more widely practiced

4. Abuses of hospital charity by those who can afford to pay must be prevented.

5 The expansion of the activities of public health departments into the clinical field should be restricted to demonstration clinics for educational purposes and to such other activities as can be made available to the community only by the use of public funds.

6 The education of the public in regard to health matters and the postgraduate instruction of physicians should be more widely developed and finally

7 The quality of service supplied to the community should be recognized both by the public and by the medical profession as the first and most important consideration in every plan which is formulated for providing more efficient surgical service and for making this service available to all classes of the population.



CHARLES ADAMS
1847-1924

MASTER SURGEONS OF AMERICA

CHARLES ADAMS

IN the summer of 1924 a group of doctors gathered at a dinner in the Army and Navy Club of Chicago with the object of formulating a memorial to their friend and teacher Charles Adams the source of much inspiration, to them especially as regards the finer things in the practice of surgery. After some discussion it was found that each of those assembled had been touched in a personal and intimate manner by his contact with Dr. Adams and so it was decided that each should write a letter telling what he felt Charles Adams had done for him in shaping his career. The opinions varied greatly and showed in how many ways Dr. Adams with his great fund of knowledge and experience had helped his students. This incident does much to show the character of the subject of this sketch.

Charles Adams was born in the village of Flore, Northamptonshire, England May 29, 1847, the county that gave to America the families of George Washington Benjamin Franklin, William Penn and Henry Wadsworth Longfellow.

Charles had three brothers and one sister. His father, John Adams, was a rugged English farmer and stockman. His mother had been a teacher in a private school and was a woman of superior education. It is interesting to note that the father furnished the physical stamina, industry and keen knowledge of men while the mother brought culture and desire for study.

When Charles was 9 years old his family came to America and settled in Milwaukee and from there moved to Chicago where the father continued to deal in cattle and later helped to found the stockyards. At the age of 17 years, young Charles began work in his father's office but he continued his studies. He also found work under Dr. Stimson at the Chicago Academy of Science whenever he was free from his duties at his father's office. I believe that it was here that he gained the impetus that later made him a fellow of the Royal Microscopical Society of England, and in his medical career a careful student of pathology. It is a well known fact that the microscope became a close companion in his declining years at Honolulu.

Dr. Adams graduated from Hahnemann Medical College, Chicago in 1872 he served a year in the hospital and then set out for the medical centers of London, Glasgow, Edinburgh and Paris—goals of young surgeons of ambition of his

day A young scientist is fortunate if he falls under the spell of great leaders in his profession and Dr Adams was particularly fortunate in this respect In later years he told his students many anecdotes regarding the great teachers of Europe.

Dr Adams returned to Chicago to take up general practice and at this time he married Mary the daughter of Thomas S Curtis of Wellingborough, England They had one son Cuthbert, and a daughter Ethel Mrs Adams died in 1888. In 1889 Dr Adams married Mrs. Elizabeth Gaylord widow of Henry Gaylord and daughter of W H Mitchell. From 1874 to 1875 he was professor of surgical pathology in Hahnemann Medical College from 1875 to 1884 professor of the principles and practices of surgery in Chicago Homeopathic Medical College. In 1896 he gave up general practice and devoted himself exclusively to surgery.

Dr Adams was one of Chicago's pioneers in the study of pathology Even in the eighties he maintained his own laboratory and later employed from one to two technicians to run through for his microscope every tissue that came from his operating table.

In 1898 he received the degree of M.D (*ad eundem gradum*) from Rush Medical College He was consulting surgeon to the Chicago Nursing and Half Orphan Asylum the Evanston hospital Streeter Hospital St. Joseph's Hospital, and for over 25 years surgeon to the Cook County Hospital.

He was a member and past president of the American Association of Military Surgeons fellow of the Royal Microscopical Society of England fellow of the American College of Surgeons the Chicago Surgical Society the American Medical Association the Illinois Medical Society and the Chicago Medical Society.

He was an omnivorous reader and accumulated a large library both of medical and general In addition to the standard editions he was always on the lookout for rare and ancient medical books. He had a reading acquaintance with six languages and read the journals in each. In the early days of Chicago transportation was slow and much time was lost in going about from hospital to hospital Adams always carried a canvas leather bound bag that held a few of his latest medical magazines and read as he rode or waited for a bridge at the river Until I came under the influence of Osler I thought him the best read medical man in general literature I had known To have him join the family circle and read to us from the classics or some modern writer was a treat.

Adams succeeded Nicholas Senn as surgeon general of Illinois. An unusual friendship had sprung up between these men which probably was little known among their associates. Both had brilliant minds and common interests—general and military surgery. They served together in the Spanish War Both had been presidents of the Association of Military Surgeons. Senn had a dramatic personality and an enormous capacity for work. Adams was quiet and unobtrusive. Each carried on experiments in surgery and there was a constant exchange of

opinions and experience between them Senn's notable contribution was bone healing Adams carried on a series of experiments both before and after the Spanish War on gunshot wounds of the abdomen In his home for many years on a high bluff on the shores of lake Michigan north of Chicago, he carried out these investigations With all the military rifles that he could obtain he worked out the results of bullets of different trajectory, velocity and density, using dogs as experimental material, striking their abdomens at all possible angles.

Watching him in the operating room one was amazed at his dexterity, but this came from constant practice in and out of the hospital in tying knots and in the manipulation of clamps and instruments In the nineties a general surgeon was expected to do a cataract operation and a laparotomy on the same day and highly trained hands were necessary to be successful

Adams edited Senn's *Principles of Surgery* wrote notable papers on gunshot wounds and general surgery, and reviewed the surgical literature of his day His avocation was the collection of cartoons and rare books Of the two, the former seemed the most absorbing Through agents he gathered cartoons from every country where cartoons were published His collection he carefully classified over a period of years and presented to one of Chicago's public libraries.

When War was declared he was past 70 but he offered his services and was accepted

His declining years were spent in Honolulu in his beautiful Japanese home over looking the sea. Here with his books and microscope he classified the flies on the island and studied the deep sea crustacea

An analysis of Charles Adams character shows an abhorrence of ostentation, a dislike of publicity, but deep friendship for those near him, and an idealism which characterized his whole professional life

WILLIAM MCL THOMPSON

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

IN the book¹ by Dr. Crile recently published he develops the theme that certain diseases of civilized man are due to excessive activity of the brain-thyroid-adrenal-sympathetic system, which he refers to as the kinetic system of the body. The author maintains that modern high speed living overstimulates the kinetic system until it tends to dominate destructively the entire body. It is suggested that man, through orthogeny, may in time be destroyed by the same organs which have enabled him to gain such great control over his external environment. This thesis is developed by pointing out and emphasizing certain selected features of the comparative anatomy, embryology and physiology of the brain, adrenals, and thyroid. The diseases referred to particularly are neurocirculatory asthenia, hyperthyroidism, peptic ulcer and diabetes, a chapter being devoted to each. The author would treat these diseases by rationalization and rest but when these fail he would break the vicious circle in the kinetic system by denervating the adrenals. The operative technique for adrenal denervation is given in detail. The precautions to be taken are enumerated and the complications emphasized. Two hundred and thirty-three pages are devoted to the case histories of 307 patients in whom the adrenal glands were subjected to operation alone or in combination with thyroidectomy or sympathectomy. The operation has been done for epilepsy, hypertension, and psychoneuroses as well as in the aforementioned diseases. The author makes the claim that adrenal denervation is of some value in all these conditions except psychoneuroses in which it is contra-indicated. As the author states this denervating operation introduces a new principle or at least a new surgical procedure into medical thought and practice. The case reports with accompanying charts and illustrations constitute the sum total of evidence in support of the author's contention that adrenal denervation has been used successfully. In the treatment of recurrent hyperthyroidism and of certain cases of primary hyperthyroidism in the treatment of persistent or recurrent peptic ulcer and in the treatment of a limited series of cases of diabetes," and as a "routine method of treatment of neurocirculatory asthenia." A critical reader will very probably obtain the impression that the author has not proved

his case because of the equivocal nature of much of the evidence advanced. However the reader's interest will be sustained, even during the perusal of the case histories, by the charming style of the presentation and the provocative nature of the theory and evidence submitted.

Certain chapters in the book have been contributed in part or in whole by Drs. E. S. A. Klig, George Crile, Jr., E. Perry McCulloch, James Hudson Dunlap, and N. F. Hicken. A C IV

AS stated in the preface, the book² by Vehts constitutes a survey of the experimental and clinical records in the field of spinal anesthesia for the past 40 years. The author sets forth in as simple a style as is possible to describe the complicated nervous system, its various reactions and responses to spinal anesthesia. He emphasizes the importance of having a thorough understanding of the nerve control of the heart, vessels, and respiratory system. Throughout the book he emphasizes the value of allowing the blood to gravitate to the heart by keeping the patient in the Trendelenburg position during the operation.

Methods to assist the heart and respiration and their vital centers during spinal nerve block are considered. The various methods of producing analgesia and anesthesia are briefly discussed and a method of the author is described in detail. Sensory nerve block is separated from motor nerve block and considered as an entity under the title of regional spinal analgesia. An excellent comparison is presented as to the relative merits of spinal and general anesthesia that all advocates of the latter would do well to review. At no time in spinal anesthesia under similar conditions are the patient's body cells subjected to the degree of acidosis and poisoning by blood urea, nitrogen and blood sugar which occurs in ether anesthesia. Either merely causes unconsciousness with little or no prevention of shock.

The indications and contra-indications for spinal anesthesia are clearly presented as well as a tabulation of its advantages. The illustrations are good and numerous charts and diagrams are presented to clarify the text.

The reviewer feels that, with the tremendous interest that has been aroused in this subject within recent years, this compact volume will be well received. He believes that too many surgeons have condemned

DRUGS PROVIDED TO CHILDS KEY, CLINICAL MANAGEMENT AND SURVIVAL. THE TREATMENT BY George Crile, M.D. New York: The MacMillan Co. 1934

SPINAL ANESTHESIA, THEORY AND CLINICAL APPLICATION BY George E. Vehts, M.D. St. Louis: L.V. Mosby 1934

spinal anesthesia after a brief trial because of failures due to a lack of proper understanding not only of the anatomy and physiology and of the various laws involved but also because of an improper technique. Frequently the method has not been at fault but rather its application. Spinal anesthesia when properly used is undoubtedly our safest and most ideal anesthetic and will doubtless remain such until superseded by the progress of science.

The reviewer appreciates that several excellent methods are being used in administering spinal anesthesia and that the essential factor is to master one of them. The method described by the author is undoubtedly a good one but would not appear as satisfactory as the one familiar to the reviewer. The all important injection of epinephrin in the inter spinous muscles 5 minutes preceding the spinal tap the use of carbon dioxide to control nausea the importance of an accurate ratio between the dosages of epinephrin, novocain and the amount of spinal fluid in governing the height and duration of spinal anesthesia are but briefly considered. The necessity of the early and continuous use of the Trendelenburg position during the course of the operation and following it is not essential to the method used by the reviewer.

These points, however are concerned merely with a difference of technique and to gain a real knowledge of the science of spinal anesthesia anyone interested in the subject can greatly clarify his knowledge of the question by a review of this volume.

ARNOLD JACKSON

THE study of chronic sinus infection as related to systemic disease is portrayed¹ in a very readable, and thorough manner by Watson Williams who has had a vast clinical experience and has made accurate observations.

Special emphasis is placed upon the value of suction—exploration whereby a cannula is placed in the infected sinus and the contents aspirated. This has proved of great value therapeutically as well as diagnostically.

While the book is essentially designed for the specialist, the busy practitioner will also find it helpful in solving some of his problems. It is complete in every detail and should be read by every one interested in focal sepsis.

JOHN F. DIERCKX

¹CHRONIC NASAL SEVERITY AND ITS RELATION TO GENERAL MEDICINE (Chronic Sinusitis and Systemic Sepsis) By Patrick W. Watson-Williams M.D., Baltimore: William Wood & Co. 1933

THE present widespread tendency of publishing books written by a group of men is followed in the book² by Adair and Stieglitz. Adair as is well known ranks among the first few authorities on obstetrics in the country, and Stieglitz for many years supervised the medical care of a large number of obstetrical patients at the Chicago Lying In Hospital. Hence a book published by such authorities should be of exceptional merit, and this is unquestionably so. The authors enlisted the aid of 37 other individuals, 29 of whom were specialists in the various branches of medicine, and 8 of whom were obstetricians and/or gynecologists. The authors have succeeded admirably in their effort to co-ordinate and correlate the medical knowledge concerning the problems of diagnosis, therapy and prognosis of diseases occurring coincidentally with pregnancy. Due to the fact that each chapter was edited by an obstetrician and also an internist, both medical and obstetrical viewpoints are presented.

The book is divided into twelve sections each of which is devoted to a special branch of medicine. The longest chapter is that devoted to diseases of the blood and this seems disproportionately large. The chapter on tropical diseases is excellent but with the exception of the 6 pages devoted to amebiasis and dysentery the remaining 28 pages are devoted to diseases which are almost unknown in this country. In the section on diseases of the heart Herrmann advocates caesarean section under local anesthesia for certain cardiac cases. The reviewer is most enthusiastic about the use of local anesthesia in obstetrics and gynecology but he would like to point out that not infrequently in patients with bad hearts there is a sudden and dangerous rise in blood pressure when the patient is being delivered under local anesthesia, either abdominally or vaginally. Hence, care should be exercised in the selection of cardiac patients for local anesthesia.

These minor criticisms cannot detract from the excellence of the book which will prove most useful to all physicians who practice obstetrics and to all specialists who see pregnant women in consultation. The book, undoubtedly will be a boon to practitioners in small communities where few specialists are available. The authors are to be highly commended for their contribution and the publishers deserve praise for the way the book has been compiled.

J. P. GREENHILL

OBSTETRIC MEDICINE; THE DIAGNOSIS AND MANAGEMENT OF THE CONCOMITANT DISEASES IN RELATION TO PREGNANCY. Edited by Fred L. Adair, M.A., M.D., F.A.C.S., and Edward J. Stieglitz, M.S., M.D., F.A.C.P. Philadelphia: Lea & Febiger 1934

AMERICAN COLLEGE OF SURGEONS

THE IMPORTANCE AND VALUE TO SCIENTIFIC MEDICINE OF ANIMAL EXPERIMENTATION

THE American College of Surgeons is presenting herewith a series of articles by recognized authorities articles which set forth the importance and the value of experimental research—research which deals with life itself and which will continue to advance human health human usefulness and human happiness for all time to come

In the words of that eminent citizen Charles W. Eliot

The number of animals used for the benefits of the human race in making possible the recent advances of surgery and medicine is insignificant, indeed infinitesimal, compared with the number used for human food and human service but the benefits to mankind which result from animal experimentation are immeasurable in quantity and very precious in quality The benefits of the discoveries go on, generation after generation, multiplying "as they go

Animal experimentation has conferred immense benefits upon mankind, and doctors themselves have volunteered as subjects when animals have not afforded suitable media for experimental research

Experimental research is one of the brightest pages in medical history and it must not cease if the welfare of humanity is to be furthered, and if medical progress is to continue

FRANKLIN H. MARTIN M.D. Director General

SIR FREDERICK G. BANTING Department of Medical Research, Ranting Institute, University of Toronto Toronto I may say that I believe in animal experimentation because I think human life is more valuable than animal life Medical science cannot advance without the use of animals. The work on diabetes and insulin could not have been done without the use of dogs.

I believe that every experiment should be well thought out and thoroughly planned before it is carried out In carrying out survival experiments on animals, the same care should be used with regard to animals as in the case of the human. It has always been our practice to administer an anesthetic to an animal before any operative procedure is carried out. The postoperative care of the animal is as important as in the case of the human. The attendants who care for the animals should be naturally fond of and kind to animals. In addition, workers should be either fully qualified or thoroughly trained before being permitted to do operations on animals.

If the above principles are carried out, the pain caused to the animal is minimized and the greatest amount of information gained.

WALTER B. CANNON George Higginson Professor of Physiology Harvard University Medical School, Boston The antivivisectionists hold the following beliefs (1) that animal experimentation in laboratories of medical research is hideously cruel, (2) that either no value has come from it that justifies its continuance or if value has come it is morally wrong to profit therefrom

The claim of cruelty has not been proved. For nearly a quarter-century rules requiring the humane treatment of experimental animals have been adopted, posted, and enforced in laboratories of medical research throughout the United States. Convinced of the real humanity of investigative methods the deans of medical schools and the directors of medical research institutes announced 20 years ago the "Open Door" policy according to which persons who had seen surgical operations would be permitted to visit the laboratories at any time and witness the proceedings. The antivivisectionists, not directly acquainted with what they write about and so ignorant of scientific description that they constantly misinterpret it prefer to use their perverted imagination instead of learning the facts. No wonder the English

Royal Commission declared that their lurid accounts of laboratory methods were calculated to mislead the public.

The claim that no value has come from animal experimentation is contrary to the formal declarations of international and national organizations, of special medical and surgical societies and of students and observers of medical history. Any one who will read the admirable collection of papers written by experts in various aspects of medicine and published by the American Medical Association, will find in them convincing evidence of the immense value of animal experimentation in the diagnosis and treatment of disease and of the consequent incalculable benefits to both lower animals and human beings. Any statement to the contrary is stupidly and absurdly false.

The claim that animal experimentation, even though beneficial, is morally wrong is in opposition to the ethics of our civilization. We kill calves and take their mothers' milk, we slaughter annually hundreds of thousands of cattle, sheep and hogs, we castrate male creatures without anesthesia, merely to make them more tractable or to please our palates, we hunt and trap with every possibility of inflicting pain. In the face of these habits, there is no reason why the use of animals in laboratories, with care to avoid causing unnecessary discomfort and with the object of increasing knowledge and lessening human misery should be regarded as specially immoral. Indeed the fact that animal experimentation has vastly reduced the suffering of mankind and that, if persisted in, it will continue to do so renders the work of medical investigation highly moral—even a moral duty.

ANTON J. CARLSON, Chairman, and Professor of Physiology, University of Chicago. Chicago. Informed laymen are well aware that animals are built on the same plan as man; they have the same organs working by the same nervous and chemical machinery. They subsist on the same kind of food and the same kind of air as man and are subjected to the same kind of disorders in the living machine as man. The causes and effects of disorders of the heart, the stomach, the lungs, the eyes, the nerves, or the brain are essentially the same in animals and man. When the experimental method was introduced in science, including the science of medicine, experiments on animals resulted in rapid progress of our understanding of the nervous and chemical machinery operating in the body in health and of the disturbances of this machinery that lead to disease. Thus animal experimentation has played a very great rôle in the

development of our knowledge of infections and their control, of anesthetics and their refinement, of disturbances in nutrition and dietary deficiencies, in the development of new drugs and their continued refinement.

There were more than 30 years of intensive research on animals before we had the substance insulin in sufficient purity to warrant its trial on diabetic patients. Every informed layman now knows the value of insulin in diabetes in man. These facts are so obvious to informed people that they would scarcely need restatement except for the additional fact that there are among us a small group of partly misinformed, partly peculiar people who oppose and would prevent all experiments on animals as cruel or useless—the so-called Antivivisectionists. This propaganda against progress in medicine sometimes goes under the name of humane education.

Cruelty is useless infliction of pain. Every normal adult human being is opposed to the useless infliction of pain, be it to man or animals, but pain unfortunately, is a part of life, in the case of man, both mental and physical pain, and in the case of animals, in all probability at least physical pain. The misinformed or misguided opponents of animal experimentation in medicine and biology would have you believe that nothing of value to man has come through animal experimentation and that animal experimentation is cruel and useless. The facts are these—while we may point with pride and cheer to the progress in our understanding of life processes, the disturbances of these processes which we call disease, and the control of disease, the fact remains that our knowledge of the causes and methods of control today are very incomplete. This is true of almost every disturbance or disease. We could probably control all diseases better if we knew everything connected with their causation and complications more completely. Some of these factors in disease appear now to be tied up with heredity and while we seem to know the A B C of heredity, largely through experiments on plants and animals, we do not know the whole alphabet. It appears to me that people who today can hold such views, that animal experimentation has been useless in the extension of our knowledge of the causes and control of diseases are either exceedingly misinformed or exceedingly peculiar people. It appears very clear to me that we must study every page of nature's book before we throw up our hands in despair at achieving a society freer from disease from pain, from defects that at present render life unhappy both in man and beasts. Let us not forget that animal experimentation has

made almost as much progress in working out the causes and control of animal disorders as of disorders in man.

Finally we have the accusation that research biologists and physicians who resort to animal experimentation to further human knowledge are practicing cruelty to animals. In the first place, many of the experiments are of the so called acute type where the animal is put under complete anesthesia during the observations and is never allowed to recover from the anesthetic. There can be no cruelty in such a process. This includes all animals used in teaching or practice training for physicians and surgeons.

In the second place, there are chronic experiments involved in research calling for operative interference with this or that organ—these animals are put under complete anesthesia during the operation, the operations must be aseptic as in similar operations on humans, and the animals are cared for after operation as completely as human patients.

In the third place, a great many experiments on animals in the field of nutrition or in the reaction to drugs involve no cutting or opening of the body. They may involve the slight momentary discomfort of a hypodermic injection, that is, a needle prick or a mosquito sting to man.

To call such investigative methods cruelty seems to me to indicate loss of the sense of proportion. They do not call for specific prohibitive legislation in the city, state or nation over and above our common humane laws. In practical life animals, as well as plants, must be adjusted primarily in the interest of man. We do so necessarily in the case of bacteria, flies, rats, insects, and all manner of wild and domestic animals. In my philosophy, man comes first. I will gladly contribute to shelter for stray or uncared for dogs when my fellow humans, and particularly children, are adequately cared for, but I am unable to account for the repeated charge of cruelty of animal experimentation and cruelty in the experimenter by apparently sane people who do not take the trouble to visit the university laboratories and the hospitals where such experiments are going on, or take the trouble to investigate the reputation for cruelty of the individual investigator. Some of the finest specimens of men and women that it has been my privilege to meet in my long life have been investigators in biology and medicine, particularly by methods of animal experimentation, and such well known humane citizens as Dean Gilkey and Rabbi Mann have for years upheld and defended the necessity and utility of animal experimentation in medical research and medical teaching.

ALEXIS CARREL, Member The Rockefeller Institute for Medical Research, New York. Every civilized human being should support the American College of Surgeons in its endeavor to check the activities of the National Anti Vivisection Society. Once more well meaning but ignorant people have banded together to oppose the progress of science. Such an event has often occurred in the course of history but it is particularly dangerous at this time. Although we are effectively protected against plague, yellow fever, cholera, typhus, tetanus, typhoid fever, diphtheria, etc., we are still exposed to countless diseases. Almost all misery comes from illness,—illness of the mind as well as the body. Modern man is suffering from cruel, lingering diseases, such as cancer, heart lesions, diabetes, Bright's disease, feeble-mindedness, insanity, and criminality. He often has not enough vitality and intelligence and is often too weak to face the difficulties of existence. We do not know as yet the precise causes of these evils. We have to discover them. But we cannot experiment on human beings. Even if experimentation were possible its results would be too slow and it would take one hundred years to ascertain the effects on a group of human beings of a given diet, of a given chemical or a given mode of education or of life. The experiments on guinea pigs, rats, and mice which live a much shorter time than man, have helped a great deal. These animals, however, are very different from us; their intelligence is rudimentary. We must use monkeys and dogs for the elucidation of the human problems—the problems which concern both the body and the mind of millions of people. Biological research is our only hope of learning how to protect human beings against suffering and death. Would those who wish to deprive scientists of their weapons against disease advocate the disarmament of the entire police force of the United States, and the free play of gangsters against the public?

GEORGE CREE, Director Cleveland Clinic, Cleveland, Ohio. The rarity of disease in animals is to a large extent due to scientific researches planned for the purpose of discovering the cause and method of prevention of such diseases as tuberculosis, cholera, and rabies. These researches have been carried on by subjecting animals to the necessary experimentation. It is apparent, therefore, that domestic animals have profited greatly by experiments made upon themselves in scientific researches.

Among the animals that have received the greatest benefit from experimental medicine is

the dog. One of the great menaces to his life, a disease which has produced great distress in its slow tortuous death, is rabies. This disease has now been practically eliminated as the result of experimentation upon the dog himself. The distemper also that affects so many dogs has been now largely cured as the result of experimentation upon dogs by means of which the cause of distemper has been discovered and a vaccine for its treatment has been developed. If the dog himself were to make a statement regarding the use of a limited number of his own kind for the discovery and the cure of a disease that menaces him, he would be just as much in favor of this practice as is the human being just as in the case of yellow fever and of other diseases in which human beings have sacrificed themselves in an effort to discover their causes and to devise methods of prevention and treatment.

The enormous number of cases of sickness and death among the two billions of human beings always present on the earth has actually contributed to the welfare of the dog and other domestic animals for as the result of the study of the cause of the diseases that affect human beings the domestic animals also have benefited. The principles of surgery and preventive medicine which are applied to man are as effective when applied to dogs and cats and horses by the veterinarian. Moreover, the dog has benefited from the use of other animals in the experimental laboratory where a vastly larger number of rats, mice, guinea pigs, and rabbits are used. The number of these animals used in proportion to the number of dogs, being certainly not less than 1 000 to 1.

Neither man himself nor any one species of animal is entitled to be excluded from taking his part in the drama of life. Certainly our guest animal, the dog, should carry a little of the burden

pled with the studies of such problems as the Early Stages of Inflammation, the "Physiology of Involuntary Muscular Fibers, the Coagulation of the Blood, and the Nature of Fermentation and Putrefaction" all based more or less on animal experiments.

Every one should be familiar with the history of animal plagues which in every age has led to untold suffering and death to countless millions of animals both wild and domestic. Often these widespread epidemic diseases involved human beings. They are referred to in the Bible and in the annals of every people. Such diseases exist today and many are readily transferred to humans. Examples are anthrax, glanders, dog distemper, tuberculosis, hydrophobia or rabies, and undulant fever. At the present time in all civilized countries these diseases are now either under control or are being rapidly eradicated. Every honest person even to some degree familiar with the facts, will admit that this control of the great animal and human epidemics with the accompanying alleviation of pain, suffering, and misery in both animals and man is due in the main to knowledge acquired by the study and experiments on animals by both medical men and veterinarians.

The value of serums and vaccines for the prevention and cure of disease is known and conceded by all intelligent persons. Their discovery and use marks this age as the great humanitarian era. For the control and prevention of such diseases as infantile paralysis, encephalitis (sleeping sickness), pandemic influenza, typhus fever, Rocky Mountain spotted fever, and many other recent and ancient diseases, our only hope lies in the use of vaccines and serums. Already note the advances made in the prevention of Rocky Mountain fever by a tick vaccine for which discovery recently the annual gold medal of the American Medical Association was awarded.

D. J. DAVIS, Dean, University of Illinois College of Medicine, Chicago. Before the beginning of human dissection the ancients acquired much valuable information in anatomy, physiology and surgery from studies on the lower forms of life especially the domestic animals.

During the renaissance period many fundamental discoveries such as the circulation of the blood by Harvey were made largely through animal experimentation and especially on dogs.

The greatest single discovery leading to the alleviation of suffering and pain that of anesthesia, was initiated, controlled and perfected mainly by properly devised animal experiments.

The early career of Lord Lister the renowned discoverer and promoter of antiseptics, was occu-

LOYAL DAVIS, Professor of Surgery and Chairman, Division of Surgery, Northwestern University Medical School, Chicago. The antivivisectionist should commune with himself and answer these questions honestly. Am I willing to refuse all medical or surgical treatment for myself, or my children the value results, and methods of which have been learned from animal experimentation? Am I willing to subject my child to a death rate of over 50 per cent in the treatment of diphtheria which resulted before the discovery and standardization of antitoxin as compared to the present mortality rate of two deaths per million of population? Am I willing to subject my infant to the ravages of whooping cough rather

than see that child relieved by the injection of serum? If my child or I became afflicted with diabetes am I willing to refuse the administration of insulin discovered and perfected by animal experimentation? Is the expectant mother of today ready to suffer the pains of labor without the benefit of alleviation of that pain by methods first tested upon animals? Am I willing to forego all of the therapeutic and diagnostic advances in the treatment of lung heart, and metabolic diseases which have been discovered by trial and error experiments upon animals. Am I willing to take medicine unstandardized in dosage, because of lack of animal experiments?

The antivivisectionist who can answer all of these and scores of other similar questions in the affirmative and then practices what he preaches may be lacking in wisdom but at least he is no hypocrite.

N. S. DAVIS III Assistant Professor of Medicine Northwestern University Medical School, Chicago Many of the advances in medicine and surgery during the past century have been connected with animal experimentation.

The surgeon has learned much of what he is able to do by performing operations on the small mammals. As a result he has acquired technical skill and a knowledge of how much can be done without endangering the animal's life. In the preparation of prophylactic and therapeutic sera for commercial use animal experimentation is necessary. Because of the sensitiveness which many people acquire after receiving an injection of one type of animal serum it is advisable that sera for different diseases be made from different animals. Sera of great value in the treatment of diseases of animals have also been developed as a result of experimentation. Furthermore, it is impossible to assay such drugs as digitalis and insulin except by the reaction of the experimental animal to a given amount of each preparation. Merely weighing or measuring the amount of the substance does not give this information. Insulin could never have been produced commercially and could not have come into general use in the treatment of diabetes if a method of assaying had not been developed. Digitalis has become a much more effective drug since it has been standardized by its effect on animals. The physician is now able to know the effective dose he is prescribing without much regard to the weight of the digitalis in the dose. He prescribes units of digitalis rather than grams of digitalis, just as he prescribes units of insulin rather than cubic centimeters of insulin solution. Animal experimentation has also been of great value in determining the potency of ex-

tracts of the various glands of internal secretion. This is especially true of some of the extracts of the ovary that are proving to be of great therapeutic value.

Little if any progress along any of these lines could have been made without animal experimentation. Anything that would make it impossible for such work to continue would not only stop progress in the medical sciences but would also cause a regression to conditions that existed before animal experimentation was developed.

WILLIAM H. FELDMAN Assistant Professor of Comparative Pathology The Mayo Foundation, Rochester Minnesota In the United States in 1914 hog cholera caused losses estimated at \$100,000,000 and made swine husbandry a decidedly uncertain and hazardous business. By animal experimentation there was made available anti-hog cholera serum and by the use of this product the loss of hogs in the United States was reduced from nearly 13 per cent in 1914 to approximately 4 per cent during the succeeding 5 year period. At the present time, by proper procedures of immunization nearly 100 per cent protection may be secured. This is only one example in which the use of animals in experimental medicine has been of inestimable value to the livestock industry. Experimental procedures in which laboratory animals have played significant roles have also made possible the production of agents for the protection of farm animals against such diseases as black leg, anthrax, and tetanus. In addition experimental methods that would have been impossible without the use of animals have netted results that provide the dog owner with means to protect his pet against canine distemper and rabies. Valuable information concerning venous and often fatal forms of internal parasitism of dogs and other animals has also been obtained by use of laboratory animals.

The sum total of the gains made in controlling and eradicating the infectious diseases of the domesticated animals by the use of experimental animals is so impressive as to leave no doubt as to the soundness of this method of research.

To prohibit the use of animals in laboratory procedures would be disastrous for the livestock industry since it would be no longer possible to

- 1 Manufacture anti-hog cholera serum and test its potency
- 2 Test the potency and safety of biologic agents designed to protect cattle against black leg
- 3 Prepare products for the protection and treatment of animals and man exposed to or afflicted with anthrax.

4. Produce and test the potency and safety of antitetanus serum.

5. Prepare agents for immunization against rabies.

It would seem neither humane nor economically wise to relinquish the advantages science has finally achieved in the attack against diseases that have long occasioned tremendous monetary losses as well as distress and suffering to both animal and man and which finally have been brought under control by animal experimentation.

SIMON FLEXNER, The Rockefeller Institute for Medical Research New York We are used to being told that we are today living in a new world. We are even used to being told just at the moment that there is doubt whether the conditions of the new world in which we live are better, indeed they may be worse than those of the world in which our parents and their parents lived their lives.

However that may be, socially or economically considered, I am confident there can be no doubt that our state, medically regarded, is far better today than in any previous period of the world's history. This fact I feel requires no undue emphasis. There is today less illness in relation to the population with fewer deaths and longer expectation of life than ever before.

While all this is true and perhaps quite generally known and appreciated, it is not as generally understood as it should be, how these great changes and improvements in health have been brought about, and what greater improvements and benefits may be expected in the next period if the science of medicine is permitted to continue its progress free from the hampering restrictions and obstructions which certain misguided persons would put in its path.

Suppose, for the sake of comparison, that we imagine ourselves back in the year 1870 which in this country was in the period immediately following the Civil War during which vast experience was gained in medicine and surgery as understood and practiced at that time. These experiences, by no means pleasant to contemplate are described in records and biographies of the hospital surgeons of the time. We shall be transported into a period before bacteriology became a science before the amazing discoveries in bacteriology of the Frenchman Pasteur and the German Koch had disclosed the germ nature of wound infection and the contagious diseases and before the Scotch surgeon Lister basing his investigations on the discoveries of Pasteur had intro-

duced antiseptic, soon changed to aseptic, surgery into practice. There are still living a few surgeons who can recall the horrors of those distressing days when wound infection was rampant, and compare them with the present state of surgical practice, so safe and widely employed that no part of the body, not even the heart and brain, are considered too sacred to be forbidden the exploration of the surgeon's knife. In those earlier days, surgery was limited almost wholly to operations on the surface and extremities of the body to invade the interior was to invite almost certain disaster. It was to be undertaken only by the boldest and most expert surgeons, and then only when not to operate was even more hazardous than to do so.

All this was changed by the medical research of Pasteur and Lister and Koch in the next quarter of a century. Their investigations, carried out chiefly in the laboratory and at first on animals, provided the scientific foundations for present day bacteriology and operative surgery, the technique of which has gradually been perfected, extended, and taught until every city and town has the incalculable benefit of the skilled diagnosis of disease and skilled surgery when needed.

There is no opportunity to deal with details. The knowledge of bacteriology was acquired slowly and for its acquisition demanded the unremitting labors of very talented men, who succeeded not only through inspiration and effort, but even against much opposition. I have indicated that the discoveries in bacteriology provided the explanation of the sources of wound infection and thus led to the perfection of surgical operative technique. These discoveries also led to the explanation of the nature of the common infectious and contagious diseases. Just as wound infection results from the presence of one class of bacteria at the site of operation so do the infectious and contagious diseases result from the presence of particular bacteria within the body.

Those were great days in the last decades of the nineteenth century which brought to light and opened to experimental study the bacteria producing tuberculosis typhoid fever diphtheria and epidemic meningitis to mention a few notable examples only and led to the fundamental discoveries in immunity to disease. From the knowledge resulting from these laboratory discoveries we can date those improvements in public health administration which have had so potent an influence in reducing the number of cases and the fatalities of such common infectious diseases as those already enumerated and as by products (and notwithstanding the fact that their germ

causes were revealed 20 or more years later) of measles, scarlet fever and other contagious diseases of childhood.

There is great temptation to introduce figures into this story but space forbids. I must, however mention one startling change in the prevalence of a disease formerly so destructive among children. In 1894, before the use of diphtheria antitoxin was introduced, 4,530 persons in New York City died of this disease which is at the rate of 103 per 100 000 of population. In contrast to these figures are to be placed those of the year 1932. In that year there were 212 deaths from diphtheria, or 3 per 100 000 of population.

These are triumphs indeed the effects of which may be read on every hand in the tables of mortality among infants, children, and adolescents and which have led to an increase of at least 12 years in the individual expectation of life in the culturally advanced countries. For a time this progress, if not arrested was at least greatly diminished in speed. The reason was that the improvements in the public health which resulted from the amazing discoveries in bacteriology affected chiefly the infectious diseases of early life and the extent and safety of operative surgery. The effects of these discoveries and the practical health measures based on them were experienced in individuals approximately up to the thirty-fifth to the fortieth year of life. The benefits were thus limited because the diseases of past middle life present another character and are due chiefly to causes other than those of the diseases of earlier decades.

Just now and after an interval in which the science of physiology had first to be further built up—precisely as the science of bacteriology had to be developed in the earlier years—progress in the control of disease has been resumed. In this intervening period physiologists have disclosed the function or mode of action of a group of glands of the body called "ductless" because of their anatomical structure which had remained enigmas for hundreds of years. The normal action of these glands is essential to the maintenance of health and their derangement is responsible, as we have now learned for serious and fatal diseases as age advances. It is because of the discoveries regarding the nature of the thyroid, adrenal, and pituitary glands, and of certain secondary but similar essential activities of such organs as the pancreas and liver that increased control is being achieved of certain diseases of past middle life, among which diabetes and pernicious anemia may be singled out for mention. We are in the beginning stages of this advance at the present

time progress is almost continuous at the moment a bright hope has, therefore, awakened in the hearts of informed physicians and laboratory investigators that the next years will witness a still greater acceleration of the control of chronic disease compared with which the progress already made, considerable as it is, will appear to have been only a beginning.

Here also are triumphs, to be converted into still greater achievements, if the growth of science is to continue unimpeded. You will have perceived that I have omitted to mention still other successes of magnitude in regard to the prevention and cure of disease which result from the discoveries relating to vitamins, light rays, and chemical products or drugs, of which much might be related.

And now what is it that the experimenter in the laboratory does that has yielded so much already to mitigate disease improve health and lengthen life, and why is the continuation of his work unfettered by injurious restrictions so essential to further progress? The experimenter studies disease on the lower animals whenever possible and always under controlled and humane conditions. He seeks to discover the nature of the conditions responsible for disease, just as the chemist and physicist seek to discover by experiment the nature of the phenomena of matter. There are only two ways of learning about things—observation and experiment. For centuries, very learned and gifted men sought to learn about disease from observation alone; the modern medical era which in spite of its brevity, has triumphed so gloriously over all past eras, has progressed through the employment of the experimental method. By this method, the element of control is introduced into observation; thus it is possible to learn what is happening at any stage of disease, and to utilize this knowledge for the understanding and the better management of disease itself.

Great as is the progress of which I have been speaking, there are hard problems immediately ahead to which answers, at least sufficient answers, have not yet been obtained. I have pointed, with what I hope is pardonable pride, to the decrease in such diseases as tuberculosis, typhoid fever, and diphtheria, but what is to be said of cancer, Bright's disease and diseases of the heart and blood vessels? You all know how seriously prevalent and destructive these diseases are. There is no lack of effort being made to reach a fuller understanding of their nature, origin, and control and I believe that progress is being made. The ultimate goal seems, however still distant; there is but one way I submit, to bring that goal

within reasonable hope of being reached finally—and that is by continued, unremitting, unobstructed study by the experimental method.

A final word. This paper seems to deal with disease in man, and it does. But every essential thing which it covers can be applied equally to disease in animals and even in plants. Everywhere in this country are institutions supported by state or federal funds, in which animal and plant pathology are being studied. The advances which have so far been made and which are continuing and becoming ever more rapid, have gone hand in hand with the advances made in the study of diseases of human beings. There are no closed compartments in nature into which man, animals, and plants can be separately placed. All are related organically and, as we may say, united physiologically and pathologically. A blow struck at experiments to solve disease in man is felt immediately by those who are endeavoring to prevent disease in animals and plants and *vice versa*. Koch developed tuberculin in the hope that with it he would benefit sufferers from tuberculosis among men; today herds are freed of tuberculous cattle by injecting tuberculin into them in order to disclose hidden foci of disease. The malign operation of mosquitoes and other biting insects in conveying disease germs is the same in principle in Texas cattle fever in malaria and yellow fever in man and in virus diseases of plants. No essential biological division exists between man and the lower animals and plants whether in respect to health or to disease. If, therefore, we would learn and through learning grow more powerful and effective to prevent and to cure disease, to lengthen life and to increase happiness through security in all its varied forms, then we should endeavor to act dispassionately and wisely in promoting the advance in knowledge which alone can free us still further from the evils of disease.

HERBERT FOX, Director, Pepper Laboratory of Clinical Medicine, Philadelphia. Having been engaged for many years in observational and investigative comparative pathology and bacteriology and as the officer in charge of a responsible clinical laboratory I know that I understand better the problems of health and disease in man because of the careful use of lower animals in investigation for comparison and contrast. My laboratories have used all kinds of animals and I know that there has been a good reason for the investigation or it would not have been done and I know the animals have been kept in as good condition as my own home animals.

In a clinical laboratory of an important hospital, no day passes in which there is not a demand for the use of animals to solve the difficult problems that are presented. Communicable disease can often only be safely discovered by the use of animals. In order to discover if vaccines and antiserum are safe to put into human beings, they must be tried upon animals. In order to discover if the apparatus and technique of departments where surgical operations are done are entirely safe, they must be checked by the use of animals.

In solving the many obscure clinical cases that are referred to the modern hospital, it is frequently obligatory that the tests be carried out by the use of animals and these are the principal but not entire list of services that the animal can yield to the sick man for his diagnosis and treatment.

Furthermore, I know that the well man of today and of the future is not safe unless he has at his disposal the protection that comes by a knowledge of normal and abnormal processes as seen in the lower animals which means that he would not be safe without the experimentation that can be carried on in laboratories.

EVARTS A. GRAHAM, Professor of Surgery, Washington University School of Medicine, St. Louis, Missouri. Not a single accredited doctor of medicine, or medical school or university in this country has ever raised a voice against vivisection. Is this failure to oppose the practice due to the fact that these groups are any less humane than other groups of society? No. It is due rather to the fact that those who are best qualified to understand realize fully that experiments on the living animal are essential to progress in the war against disease whether that disease affects only human beings or the one hand or animals themselves on the other. In the light of the amazing conquests achieved in that war by the use of vivisection how can anyone now cry "Stop!" and try to tie the hands of those investigators who are finding ways to prevent the pain and the mutilation of little children, that is still caused by disease! As it happens moreover in practically all of the work in vivisection the animal suffers no pain because the experiment is carried out in full anesthesia from which the animal is not allowed to recover.

Have the doctors any axe to grind in favoring vivisection? Is there any selfish reason for their failure to join the ranks of the antivivisectionists? The only results to be effected from animal experimentation are a better understanding of disease its nature its causes, its treatment, and even its

prevention. Can anyone call it a selfish motive for the doctors to work for the elimination of disease and thereby diminish the need of their services to the public?

Antivivisection campaigns are usually chiefly directed against the use of dogs. It is easy to understand the sentimental feeling against the use of this faithful and trusting animal for such purposes. But yet the use of dogs is often essential for the purposes of investigation. Are dogs of more value to us than our children?

STUART GRAVES, University of Alabama School of Medicine, University, Alabama. Many of our domestic animals are raised that man might live. Antivivisectionists as well as others, eat the flesh of these animals without hue and cry.

Many of the objectors to animal experimentation have undergone some form of surgical operation that their life might be saved or prolonged. Had it not been for animal experimentation especially upon dogs, the present degree of perfection in surgery would never have been made possible. There is no objection to an operation upon the ground that the sacrifice of an experimental animal made the operation possible. Operations upon the brain, stomach, liver, gall bladder, appendix, pancreas, spleen, kidneys, arteries, veins, nerves and spine and the successful use of various forms of anesthesia owe their origin as well as their success, with few exceptions, to animal experimentation.

During the Civil War the mortality rate incident to abdominal wounds was over 90 per cent. There were no abdominal operations. Surgical knowledge and experience was vague and meager. During the World War the mortality rate from abdominal wounds was only 43.32 per cent.

Abdominal wounds in the latter were more grave owing to the nature of projectiles used. Had it not been for knowledge and experience gained and perfected surgical technique developed through the use of dogs as the subject of the experiment instead of man, the World War mortality rate from abdominal wounds would have exceeded that of the Civil War.

Had it not been for the use of dogs, Banting and associates would never have given insulin to the world to prolong the life and preserve the health of diabetics. It would be interesting to know the percentage of diabetics among the antivivisectionists using insulin.

Objection is often made to animal experimentation upon the ground that it is not humane. This is sheer ignorance of fact. Experimental animals, in medical schools and other investigational in-

stitutions, are well fed and cared for. Cages and runs are well cleaned and aired. Their environment is far better for the most part, than many of our less fortunate fellow human beings, toward whom the antivivisectionists could well afford to turn in a helpful way instead of throwing a stumbling block in the progress of scientific teaching and investigation which seeks to lessen human suffering. Experimental animals are not allowed to suffer. No operations or procedure that might prove painful are done except under anesthesia.

If animal experimentation is to be prohibited the world will go back to practices of the dark ages. We will rely upon tokens, charms, superstitions, the fighting of evil spirits, and the call of the occult in vain attempt to promote health and prolong life. Medical schools would close, health departments would cease to exist. The sick and death rate would be appalling. Can the world at large afford to suffer because of the intellectual dishonesty of a misguided few?

J. P. GREENSTEIN, Associate Professor of Gynecology, Loyola University School of Medicine, Chicago. During the last few decades animal experimentation has yielded an enormous amount of valuable information to the study of childbirth. Through experiments on animals and chiefly through this means, we have gathered a vast fund of knowledge concerning menstruation, the entire process of reproduction, the transmission of substances from mother to offspring and vice versa, childlessness, miscarriages, the action of X rays and radium on the newborn child, monozygotic twins, anesthesia during childbirth, childhood fever and the effect of diet on the mother and baby. While the amount of this information is very extensive it is still insignificant compared to what is still to be learned. For the solution of most of these problems, animal experimentation is absolutely essential.

SAMUEL C. HARVEY, Professor of Surgery, Yale University School of Medicine, New Haven, Connecticut. The alternative to experimentation upon animals, and in particular dogs, is a very simple one, and that is experimentation upon man himself. Progress in knowledge of disease and its treatment cannot be stopped by the passage of antivivisection legislation, for the necessity of it is too obvious both to the physician and his patients, but it can be seriously hindered. The result will be the trial on man himself of procedures that had far better be first carried out on an experimental animal. Anyone who opposes properly conducted vivisection must either in all conscience be willing

to submit himself in place of an animal for experimentation or take the stand that no further progress in medicine shall be made, for such cannot occur without the determination of the truth by the method of trial and error. It is strange indeed that individuals exist who can face with equanimity the suffering and death of their fellow men or who do not cavil at the mutilation and killing of animals for commercial purposes but become consumed with indignation at the thought of animal experimentation carried out by the most benevolent of professions for the good of humanity.

J. SHELTON HORSLEY, St. Elizabeth's Hospital, Richmond, Virginia. No surgeon or physiologist desires to give unnecessary pain to any animal. Aside from the humane aspect, the performance of an experiment on an animal struggling and suffering is difficult and tends to make the result of the experiment uncertain. In every well established laboratory all major operative procedures are carried out under some form of anesthesia. In order to do successful surgery, not only must the mechanical technique of an operation be mastered but the surgeon should know the physiologic function of the tissues with which he is dealing in order to preserve or readjust the function.

If a child has an obstruction of the bowel or a man a strangulated hernia, or a wound in the stomach or intestine the problem of immediate surgical relief at once arises, probably removing a portion of the intestine and sewing the ends together. No one can learn to do this solely by reading about it, or by hearing someone tell about it, or even by seeing someone else do it, any more than he can learn how to pitch a curved ball, or to serve a game of tennis, by reading about it or by seeing it done. It requires the actual experience in the performance of the operation on living tissue. No matter how carefully the work may be done on the dead tissue of a cadaver there is nothing that substitutes for living tissue. The result of the experimental operation can be ascertained only by observing the animal after the operation.

The surgeon, then, is reduced to the choice of learning how to repair injured bowel on the lower animals, or of acquiring skill by his experience on human beings. If an experimental operation is done on an animal and the animal dies a post mortem examination is made to determine the cause of death. If the animal recovers it is killed under anesthesia after a number of days and the site of the operation is studied. In this way the technique of the operation of suturing the intestines may be so improved that the surgeon can,

with confidence, undertake this operation on a human being.

It is well known that the mortality rate in the first series of experimental operations on animals is higher than it is later on after the operator has become more skillful. If he is denied the opportunity of acquiring this skill by experimental operations on the lower animals he must obtain it by clinical experience on human beings and many lives will be needlessly sacrificed before the necessary training is obtained. This, of course, is only one feature of the benefits of animal experimentation, but it is very practical and striking.

Dogs eat about the same food and have somewhat the same habitat as man, and often make the best subjects for many of these experiments. The stray dogs that are gathered in a pound and killed help no one. If these animals are properly taken care of in a laboratory, operated upon painlessly and painlessly killed, they are of great use to humanity. The cook who wrings a chicken's neck to obtain a pleasing meal, the butcher who cuts a steer's throat for a tender steak, the hunter who kills big game for amusement or traps animals for their furs all seem to have at least the tacit approval of many of those who object to animal experimentation. Surely the world would seem topsy turvy if it is permitted to slaughter animals for our pleasure or appetite while the careful performance of painless experimental operations to lessen disease and to decrease the suffering and death of human beings is forbidden.

ROBERT M. HUTCHINS, President, University of Chicago. Chicago. The history of biology and medicine during the last three centuries shows that experiments on animals have played a very great rôle in advancing man's understanding and control of the processes of life in health and disease. The leaders in biology and medicine inform me that the continued use of animals is necessary in the application of much of what is known to the diagnosis, control, and cure of disease in man and animals. Furthermore, a large territory of the unknown still lies ahead of the biological and medical investigators. It seems altogether reasonable that biology and medicine of today and tomorrow should have the same freedom and support as in the past. We cannot indict the biological and medical investigators (and the institutions that sponsor their labors) on the evidence of cruelty to animals and futility in results so far offered by the opponents of animal experimentation in medical teaching and research. Very large funds, public and private are devoted to the advance of biology and medicine

by the leading universities, medical schools, and hospitals. A small group of essentially misinformed people should not be permitted to impede the service of these trusts for the benefit of mankind.

A. C. Ivy Nathan Smith Davis Professor of Physiology and Pharmacology Northwestern University Medical School Chicago Within the past 60 years remarkable, yea almost miraculous advances have been made in our knowledge of physiology and of the cause, cure, and prevention of disease. Still, everyone knows that much is yet to be accomplished. Since most of these advances have come either directly or indirectly from the use of the scientific method of animal experimentation, and since no substitute method has even been suggested it is obvious that the future progress of medicine depends to a large extent on the use of this method.

In regard to the legitimacy of this method, I adhere to the general belief held by medical scientists namely that man has the moral and ethical right to use dumb animals humanely for useful experimental purposes in order to avoid random experimentation on man, and that there are very definite limits to the experimentation that should be permitted on human subjects, whether they be patients, students, or teachers.

When the opponents of animal experimentation have sought to have laws made to abolish all animal experimentation, medical scientists have pointed out to the legislators that they must answer two questions before they vote. First, is the search for new methods of diagnosing and treating disease to continue? Second if so is the basic, preliminary and often random experimentation to be done on man or animals?

After ascertaining that legislative assemblies will not prohibit animal experimentation, the opponents of animal experimentation next seek exemption for the dog. (They thus, imply that their chief aim, as many claim is to hamper the progress of medical science rather than to "save" the dog from experimental laboratories.) Now in addition to their charges of cruelty in and lack of profit from animal experimentation, they can make an emotional appeal to the sentimental attachment that we all have for our dog. They fail to point out that people's pet dogs are not used, that only stray dogs without home owner or friend and condemned to be destroyed are used. Although all states have anti-cruelty laws, an indictment of cruelty has never been returned against a medical scientist, and to say that nothing of profit has come from the use of dogs is

to say that the lives of many people now living are of no value.

The continued use of dogs for experimental purposes is necessary for several reasons, lack of space not permitting detailed examples. First, their size renders it possible to perform operations and experiments that could not be performed on smaller animals. Second the structure and function of most of their internal organs are identical with and react to drugs as those of man. Third, the dog is much better adapted to laboratory life than for example, the pig. Fourth, in large cities, where medical schools and research institutes are found dogs are wantonly but necessarily destroyed daily at the pound while if they were humanely used in the research laboratories, their destruction would be of service to both man and animal kind.

It should be remembered that most all we know about blood pressure, the lungs, liver stomach, intestines, gall bladder pancreas, parathyroids and adrenals, and much that we know about the heart, kidneys, spinal cord brain, and metabolism, have come from experiments on the dog. The discovery of insulin, which will prolong the lives of more than one million people living in the United States today was made possible almost entirely by experiments on the dog. The discovery of the liver treatment for pernicious anemia, formerly an insidiously fatal disease came from experiments on dogs. The discovery of cortin, which prolongs the lives of patients with Addison's disease, and of parathormone, which saves the lives of patients with parathyroid tetany both came from experiments on the dog. Many delicate surgical operations, such as the suture of blood vessels, operations on the heart, brain, lungs, and intestines were first tried on dogs. Also, many methods for the diagnosis of disease of the stomach, liver gall bladder etc., were developed by experiments on the dog. These examples should be sufficient to show that the humane experimental use of the dog is necessary and that incalculable good has come from such experimentation.

It is obvious to those who know medical scientists intimately that dogs would not be used unless their use was necessary and profitable. A medical scientist quite obviously in his teaching and research selects the animal deemed to be most suitable for the purpose.

HERMAN L. KRETSCHMER, Clinical Professor of Surgery Rush Medical College University of Chicago Chicago It is a well known fact that the span of human life has been increased about

eleven years, so that our expectancy of life is just that much longer than the life expectancy of our forefathers.

This great medical achievement is in a large measure the direct result of animal experimentation—so called vivisection. Many of the terrible epidemics that caused the deaths of millions of people have been practically wiped out, and this has been made possible only by animal experimentation.

I wish to confine my remarks only to that phase of vivisection that has resulted in saving the lives of millions upon millions of children all over the world. It is much better to sacrifice the lives of any number of experimental animals rather than have one single child die.

One of the outstanding results of animal experimentation is the discovery of serums for the prevention and treatment of disease, and they play a very important rôle in the treatment of infants and children.

Diphtheria, that dreaded visitor in the home with children, has practically disappeared today. In Chicago, for example, in 1905 there were 2,220 deaths per 1,000,000. In 1933, there were only 2.5 deaths, per 1,000,000 from diphtheria. If the death rate of 1905 had existed in 1933, it would have meant that about 797 children would have died from this disease. In other words, 788 lives were saved as a result of knowledge gained through animal experimentation.

It might be well to emphasize the fact that these figures do not take into consideration the patient who suffers from diphtheria and though he recovers, often has a permanent and an irreparable damage to his heart and kidneys, and leads a life of misery as a result of this disease.

It would seem that the animal experiments which resulted in the discovery of diphtheria antitoxin for treatment and the discovery and standardization of toxoid for the prevention justify this great saving—saving the lives and health of your children and mine.

The above story can easily be repeated when applied to the treatment of other diseases in infancy and childhood. May I call your attention to the almost complete abolition of rabies (hydrophobia), lock jaw (tetanus), cerebrospinal meningitis, and scarlet fever? The extensive and intensive study that is being directed to the dreaded disease of children, namely, infantile paralysis, cannot be undertaken without animal experimentation.

Vivisection does not mean cruelty to laboratory animals. These animals are given the best of food and care—far better care than that received by

stray dogs, wandering up and down streets and alleys. Experimentation does not mean pain for the animal because all investigations are done under careful anesthesia, and the care after operation is meticulous.

And finally, may I call your attention to the fact that many humans have sacrificed themselves in the war against disease? For example, in the fight to discover the cause and method of the spread of yellow fever, there were brave men who permitted themselves to be inoculated with the germs of yellow fever to test the value of certain preventative measures against the dread disease. The number of doctors are legion who, in the study of cancer, have inoculated themselves with pieces of a cancerous tumor.

Who then could oppose the sacrifice of the lives of animals if it means progress in the battle against human disease, if it results in the prevention of epidemics in the cure of many infectious diseases and in the saving of countless human lives, and if it results in an economic saving to the individual himself and to the community as a whole?

RIGHT REVEREND WILLIAM LAWRENCE, Bishop of Massachusetts, Boston. Having been for some fifty years interested in the subject of vivisection, I have had occasion to notice various changes in the discussion.

The great improvement in the methods of vivisection has thrown into discard many of the earlier arguments and illustrations. For instance, Dr. Henry J. Bigelow, the Boston surgeon, used to be quoted as abhorring vivisection. I knew Dr. Bigelow. A keen surgeon, wonderfully rapid in his work, and of tender emotions, he shrank from such unnecessary cruelty as sometimes obtained in his day, but quotations from him today are anachronisms.

Recalling famous surgeons who have been vivisectioners and have publicly upheld vivisection, I am impressed with their humane spirit and sympathy. It has always seemed strange to me that the members of the merciful calling of medicine and surgery should be held up to public scorn by the very citizens who turn to them when in illness or pain.

Of course in earlier days, vivisection was often cruel, necessarily cruel before the discovery of anesthetics, but public opinion, the law, and the character of the men who in the course of their investigations practiced vivisection have revolutionized the methods, and in these past many years I have been amazed at the number of charges of cruelty and of illustrations which have been proved to have no basis of fact.

After all, is it not a question as to whether man shall or shall not use the lower animals (of course with all possible humane precautions) for the welfare of man?

At a hearing in the State House in Boston President Eliot, being questioned, answered that it was the problem of the use of the lower animals by man for man's welfare a principle which seems to be generally granted in our use of horses. "Indeed," he continued, "we so use the cow who passes through the agony of childbirth and from whom her child is separated, she moans as a mother bereft of her child and all for what?" (and he turned to the protesting company) "that these ladies may have milk for their luncheon."

The whole question seems to me to simmer down to this: vivisection must be in some form if men are to be healed from disease and accident; methods must be as humane as possible. The final question is, shall we vivisect men, women, and children and thus learn how to treat other men, women and children, or shall we with humane methods vivisect dogs, cats, rabbits, or mice in order that men, women and children may be healed and live?

CLARENCE COOK LITTLE, Managing Director American Society for the Control of Cancer, New York. During the past 20 years the emphasis in research on the nature and cause of cancer has shifted from a medical to a biological basis. The general consensus of opinion is that the change has opened up a number of new avenues of approach and has led us in the direction of increased knowledge and a clearer perception of truth.

Science has recognized the unique and absolutely essential part which animal experimentation has played and must continue to occupy in this field of research.

Nature has seen fit to afflict laboratory animals with many forms of cancer strikingly like those which occur in human beings. Nature has also given to such animals a far shorter life span than our own so that they attain the various ages at which certain types of cancer most commonly occur in a few months or years—instead of in several decades as we do.

These facts have combined to make laboratory mammals an effective short hand material for the purpose of research in cancer.

In view of the appalling death rate from cancer and because of its widespread incidence, research must not be hampered. The nature of cancer is such as to place almost staggering difficulties in the way of its analysis and control. Restrictive legislation of any sort concerning the use of ani-

mal material will definitely diminish and may finally preclude the chances of the conquest of this disease.

Only an eccentric, selfish, and over-emotional type of mentality can dare to attempt to obstruct science in its attempts to utilize fully every means at its disposal to learn more of the scourge which kills annually more than 120,000 of our countrymen. Those who circulate propaganda for such restriction of experimentation in cancer research should pause and ask themselves whether they care to become friends and allies of mankind's most sinister enemy.

ARNO B. LUCKHARDT, Professor of Physiology The School of Medicine of the Division of Biological Sciences, University of Chicago, Chicago. As the result of animal experimentation there is available a general anesthetic agent, namely ethylene, whose anesthetic properties could never have been discovered if animal experimentation had been denied to biologists and medical men. Ethylene is a gas which was found highly poisonous to flowering carnations and other forms of plant life. Since it was found present to a variable extent in illuminating gas, the investigators thought that its presence there might account in part for the harmful and deadly effects of illuminating gas when this latter gas is inhaled accidentally or with suicidal intent. Animal experimentation on the frog, mouse, rat, rabbit, guinea pig, cat, and dog showed that this gas ethylene given with oxygen was not poisonous to these animals. In fact, it put these animals to sleep. When the gaseous mixture of ethylene and oxygen was withdrawn the animals awoke seemingly none the worse for their experience. The investigator then inhaled the gaseous mixture themselves. The experience was pleasant. There were no after effects to indicate that the gaseous mixture, so poisonous to many forms of plant life, had the least degree of poisonous action. Further investigations showed that man, like the lower animals, was not only put to sleep but that in this sleep surgical operations were possible. At the present time it is one of the safest if not the safest, of anesthetic agents for human beings. Could the anesthetic properties of this agent so useful to the surgeon and patient have been discovered in any other way than by animal experimentation?

FRED B. LUND, Surgeon in Chief, Carney Hospital, Boston. There are many important considerations which one should bear in mind before voting to restrict or hamper animal experimentation. First, let us consider universal epidemics.

of small pox which used to devastate the world before vaccination and then remember that first inoculation and then vaccination were established not by experiments on animals but on human beings, who voluntarily offered themselves for new treatment in the hope which has been justified, of saving mankind from this terrible scourge. Millions of human lives have thus been saved. Second, one might walk in retrospect through the wards of a city hospital before diphtheria antitoxin was used and watch the babies choke to death, in spite of all that could be done. A fearful sight it was, one which now is seen no more. Third, we should remember, that the discovery and preparation of diphtheria antitoxin was and is dependent upon experimentation on animals. Hundreds of thousands of innocent children have been saved from a horrible death by diphtheria antitoxin, and if you count the agony which their parents have been spared it is hard to reckon the good that has been done. Fourth let us consider the question of typhoid fever. If one walked through the military hospitals during the Spanish war, he saw thousands of the flower of our youth perishing of this deadly fever but how different are the statistics of all the countries engaged in the World War. In this great war millions of men were involved, but they were all given inoculations, and we learn that a case of typhoid was the rarest thing in the world and that this dread disease hardly counted in the mortality statistics. In our great city hospitals today typhoid fever is so rare that it is difficult to find a case to demonstrate to medical students. This means that thousands of lives have been spared and that an enormous amount of suffering, misery, and expense has been saved for mankind. Such an improvement could not have been arrived at without the use of animals for experimentation and for the preparation of the serum. Fifth let us think of tetanus or lock jaw that scourge of surgical injuries and wounds which in all wars killed its thousands. In the World War antitoxin given as a routine for prevention so thoroughly stamped out tetanus that death from it was almost unknown. To be sure a few old worn out horses had to be kept in comfort in their old age in order to have blood painlessly drawn from their veins to provide the serum, but that surely ought not to count for much in comparison with the enormous saving in human life, for before the use of antitoxin tetanus was fatal in 75 per cent of the cases.

It has been repeatedly demonstrated that doctors will give their own lives to increase knowledge. Think of Walter Reid! The question comes

down to this are the lives of a few dogs cats rabbits, and guinea pigs to be compared with that of thousands hundreds of thousands of human babies?

The contributions of animal experimentation to surgery can hardly be estimated. Suffice it to say that the operation of transfusion of blood which had been attempted through the centuries, had to be worked out on animals before it could be applied in emergencies. The skill and delicate handling necessary to perform it could be acquired in this way alone. Only after such training could it be safely or effectively used in human beings.

All of the animals used in experiments do not die. Many of them live for many years under a loving care which they never would have had unless they had been fortunate enough to be selected for experimentation. All that are operated on at all are given anesthesia. They do not suffer pain.

For which will you vote for the lives of thousands of babies or of a few dogs, cats, and rabbits painlessly sacrificed that men, women, and children may live? Will you allow bunting which means the sacrifice of thousands of animals without anesthesia and prevent the painless sacrifice of a few animals in order that thousands of our fellow human beings may be saved from death, and what is more, chronic painful disease?

Any public official who would choose the latter alternative has been described by the immortal English poet.

Man proud man, clothed in a little brief authority
Most ignorant of what he's most assured!
His glassy essence like an angry ape
Plays such fantastic tricks before high heaven
As make the angels weep."

G. W. McCoy, Director, National Institute of Health, United States Public Health Service, Washington. The march of civilization is replete with invention and discovery, largely attained through empirical methods of learning. In applying these methods man has had to avail himself of the materials at hand, fitting the means to the end and holding himself ready at all times to change his basis of experimentation to one more promising.

In perhaps no scientific endeavor is this more evident than in medical and surgical research where animals are used for experimental and test purposes, the ultimate trial taking place in man's own body. Much thought has been given and many efforts have been made toward devising satisfactory ways of studying certain diseases in lieu of animal experimentation. No physical or chemical processes have yet been found equal to

the biological approach to the solution of problems surrounding many of the pathological conditions of plants, animals, and man. Until such procedures are evolved there appears no choice, if a successful outcome is to be achieved, other than the use of animals in prosecuting medical research. And it cannot be denied that the results already accrued have been of such incalculable benefit to both man and animals as to justify a continuation of these methods.

GEORGE R. MINOT, Professor of Medicine, Harvard University Medical School, Boston. Much has been written concerning the benefits to mankind from animal investigation relating to infectious diseases. It is well known that modern medicine dates from the years 1865 to 1875 when Pasteur and Koch through experiments upon birds and mammals demonstrated that tiny organisms called bacteria were the cause of infectious disease. This led at once to the separation of infectious diseases into definite disorders caused by different kinds of bacteria. As further experiments progressed, it was found out that although these bacteria did harm certain animals recovered. A study of the latter gave hints as to how to aid people suffering from special infections. Next in importance was the impetus given to surgery. The surgeon having been shown by animal investigations how to kill bacteria, developed the methods of sterilization and discovered that wounds healed kindly if not infected.

But long ago it was recognized that only a fragment of illnesses is due to bacteria. Thus cancer and other tumors, gout, diabetes, pernicious anemia, and such dietary deficiency diseases as scurvy and pellagra were obviously disorders of a different type. And though it is not so generally recognized animal investigation in relation to such diseases has been almost as fruitful as in relation to those disorders due to bacteria.

Thus diabetes, a terrible scourge due to an inability of the body to utilize properly sugar and similar foods, has been greatly mitigated by the discovery of insulin. It was known for a long time that if the pancreas, a gland in the abdomen connected with digestion, was removed from dogs, diabetes resulted. Many investigators studied this problem and several just missed its elucidation and it was not until 1921 that Banting and Best finally extracted from the pancreas of dogs by a special method a substance, now known as insulin, which, when injected into the animals already made diabetic, relieved them of their disorder. Since that day thousands of sufferers from this malady have had their lives prolonged in com-

fort and must worship at the feet of those investigators and those animals whose work and sacrifice makes their living possible.

A somewhat similar story can be told of the relief to sufferers from pernicious anemia, a disease heretofore always fatal, through the discovery that the feeding of animals livers and liver extracts, or injection of the latter may maintain health for these individuals. Investigations on animals pointed out the effect of liver feeding upon growth upon blood regeneration under certain circumstances, and had served to enhance essential knowledge concerning the blood. From such stepping stones combined with observations made during life and after death on various sorts of patients came the modern use of liver extracts and during their development animals were employed to determine if the products would be toxic for man.

The future solution of the cancer problem and many other conditions which are enemies to man in all probability will be solved in part by wise, judicious use of animal experimentation.

LOUIS D. MOORHEAD, Dean, Loyola University School of Medicine, Chicago. The use of animals is essential in the teaching of physiology and of surgery. In these subjects, even more than in chemistry or physics, the student must learn in part by doing work with his own hands. If a young surgeon were about to perform on my body his first major operation on a human being, I should be glad to know that he had passed a written examination on his surgery text. I should also be glad to know that he had watched experienced surgeons at work, had even held retractors and applied sponges for them. But I should be still further comforted by an assurance that he had himself successfully carried out, upon dogs, operations similar to that for which I was being prepared.

It is not necessary here to mention the contributions which have been made to medicine by experimental work on animals. Diphtheria antitoxin alone has saved thousands of lives. In modern times there has probably lived no greater benefactor of humanity than Pasteur. In an antivivisectionist state his career would have been cut short, for after the publication of his first animal experiments he would have been committed to jail.

Abolition of the use of animals would not only block further discoveries in medicine but would make difficult or impossible the employment of several valuable drugs. Some of these as small-pox vaccine and diphtheria antitoxin, require

living animals for their preparation, others as insulin and viosterol cannot be prepared in known strength by chemical methods, and must be assayed as to potency by trial administration to animals.

WILLIAM P. MURPHY, Instructor in Medicine, Harvard University Medical School, Boston. As one of the great army of dog and animal lovers among the medical profession, and as one vitally interested in alleviation of the illnesses and sufferings of humanity, I can scarcely overlook the great contributions to the healing art which have been made possible by our animal friends.

Even the physician in daily contact with sick men, women, and children cannot realize the myriad ways in which suffering is relieved and life prolonged through these contributions. How often the physician sees the almost miraculous return to life and then to economic efficiency through the use of digitalis in the patient whose heart muscle has been damaged or overworked and so fails to carry on its normal function. It has become possible to bring about such relief promptly, and with a degree of certainty, only through the accurate standardization of the effect of digitalis preparations by the use of cats.

Who can forget the hundreds of emaciated sick little children who remained hopeless invalids and did not grow to maturity in the days before insulin became available? Rarely do we realize that much of our present knowledge of the use of insulin enabling diabetic children, as well as their fathers and mothers to live happy, useful lives has been made possible through the aid of our dog friends.

It is impossible even to think of the many ways in which each of us has been relieved of or spared suffering even though we have not individually had the misfortune to be ill. Daily, patients are being aided through a critical attack of pneumonia as a result of the development of a serum no longer do we have serious epidemics of smallpox or diphtheria the victims of rabies, as the result of a "mad dog" bite are no longer watched through an agonizing illness resulting in death. Daily thousands are saved from invalidism or death through the skill and knowledge of our surgeons, made possible only through the intimate study of the animal anatomy and the effects of their procedures on animals which must of necessity be carried out as humanely and skillfully as they must later be done to save a human life.

In view of the great advances for the relief of human suffering which have only been possible through the study of animals in the laboratory

and through the realization that the great body of medical men are lovers of animals, in particular, dogs so that only the most humane methods are used in the laboratory it is difficult to understand how a sane thinking individual cognizant of the sufferings of little children, men, and women can attempt to hinder further progress in the prevention and relief of this suffering.

WILLIAM H. PARK, Department of Health, Bureau of Laboratories, New York. At the present time we are deeply interested in making a vaccine which will produce immunity against poliomyelitis, a disease to which only the monkey and the human being are susceptible. To obtain such a vaccine therefore we must test it out in either the human being or the monkey. It is hard to believe that any one would suggest the use of children for such a purpose or that it would be used until we are perfectly certain that the vaccine will be safe and probably effective. Therefore, we have used more than 200 monkeys to determine the best methods of preparing the vaccine to test it for efficacy and harmlessness. Since completing our experiments we have vaccinated some 30 children, all of whom have become immune and none of whom has suffered in the slightest from the injection.

Again, there is the question of diphtheria. Without the use of the guinea pig it would not have been possible to learn the value of diphtheria antitoxin, toxin-antitoxin, or of toxoid. Through the use of these animals we have been able to develop potent antitoxins and potent vaccines so that diphtheria is gradually being conquered. I understand from the health commissioner of Chicago, Dr. Bundesen, that there were only 7 deaths last year in Chicago from diphtheria. In this city there were only 86. Without the use of antitoxin we believe there would have been between 5,000 and 10,000 deaths. Could any thoughtful person really believe that it was not right to use these animals in this tremendous service to humanity? It may be of interest to know that these animals would never have been born under the best conditions and have been kept with such care for a number of months if they were not to be used for experimental purposes.

As is well known a great deal of effort has been made to produce a vaccine to lessen the ravages of tuberculosis. It has taken several years of work and quite a number of rabbits to satisfy ourselves that the BCG vaccine does produce a definite amount of resistance in those vaccinated with it and also that no danger will result from its use.

Our antipneumococcus serum which is giving such fine results in certain types of pneumonia can be standardized only by the use of white mice. Would any one having an attack of pneumonia doubt the value and the propriety of using white mice to standardize the potency of the serum so that a proper amount might be given and the proper type of serum used?

For the production of the Pasteur treatment against the dreaded hydrophobia, the rabbit is the only means we have of producing the vaccine. Would any human being be willing to state that a person bitten by a rabid dog should not receive the vaccine because a rabbit had suffered death in its production?

I think these instances are enough to show the immense importance and the necessity of the use of animals in the perfection of serums and vaccines and for testing the potency of these serums and vaccines. Surprisingly little pain is given to the animals in our experimental work. Except for a few hours of actual distress before their death they suffer very little. It would be a great loss to the human race if those who are opposed to the use of animals for these purposes should make it impossible to carry on this work.

C. I. RICH, Assistant Professor of Physiology, University of Illinois College of Medicine, Chicago. There is a great amount of medical knowledge that has been acquired by observation and deduction. Much of this type of information was acquired hundreds of years ago. But in spite of the ready availability of this knowledge in case of nearly all diseases, there was progress only to a certain point. Beyond this point no progress was made until experimental methods were adopted. To some extent the human patient may serve as a subject. But the experimental procedures that have yielded the most important knowledge are of such a nature that they cannot be employed except on animals.

No one will claim that all lines of experimental effort will lead directly to the cure of a disease. Some diseases may be controlled by purely empirical methods usually discovered by chance. Others may be controlled only by a rational comprehension of the underlying factors involved. Many experiments are undertaken solely for the purpose of acquiring this fundamental knowledge which is just as necessary in repairing the human body as for a mechanic to know the fundamental nature of a machine in order to repair it.

Our present knowledge of cerebral function was not possible until brain surgery on dogs was undertaken. The nature of cardiac function be-

came apparent only after experiments were done on the hearts of many lower species. No progress was made in the control of many gastro-intestinal disturbances until experiments on animals revealed the fundamental functional processes involved.

The antivivisectionist says that our efforts have been useless because we cannot cure the common cold. The answer to this type of argument is that experimental investigation in human disease was not employed extensively until about a hundred years ago, whereas the experimental method was employed in other fields of science much earlier. If certain conditions have not yet been brought under control it means that we must do still more, not less, experimenting.

It would be quite as logical to say to the physicist, "You have not produced a perfect radio set, therefore you must stop the useless squander of time and money" as to insist that animal experiments cease because perfect results have not yet been secured.

PETER ROSS, The Rockefeller Institute for Medical Research, New York. Man has always striven to cure disease and prevent death. During thousands of years he could but look, guess, try, and slowly gather experience. Now in the last two generations he has found out how to do more. Anesthetics let him enter the living body without pain and the precautions learned through experiments upon animals permit him to do so without danger. For the first time he can put his wits to work against disease by effectual methods. The most precious of these proven such over and over is animal experimentation. By looking inside animals, producing disease in them, and attempting its cure, physicians find out how both animal and human bodies behave and what to do when they are sick. They learn for the many by sacrificing the few. The facts already discovered have prevented countless children from choking with diphtheria, kept innumerable wounds from mortifying, alleviated heart disease, controlled pernicious anemia, saved diabetics, provided means to avert distemper from dogs, and done away with important cattle, poultry and swine plagues. Childbirth has been made safer, life easier and far longer and the act of dying more tolerable. Yet living creatures still suffer too much and die too young. Is it not common sense to go on trying to help them by a method which has already yielded such gains? And common sense to utilize for the purpose the kind of animal required for new discoveries? No one wishes to experiment upon the dog. But the dog

is more than man's friend. He is man's near neighbor physically. In his build, his diet, and the changes sickness produces in him he resembles man far more than do the other available creatures. Scientists could not have found out about some diseases, human and animal, had he not been experimented upon nor can they do so in the future without him.

BELA SCHICK, The Mount Sinai Hospital, New York. The necessity of using animals for experimental medical purposes and the control of curative remedies is clear in the case of diphtheria. It was possible to study this dreadful disease, which is now under control only by using guinea pigs and horses. Guinea pigs are the only animals which show the classical effect of the diphtheria toxin. They must be used if we want to know the virulence of the diphtheria bacillus and its toxin. In case of doubt as to whether a child is suffering with diphtheria or whether an individual is a carrier of innocent pseudo diphtheria bacilli or of real virulent diphtheria bacilli, the bacilli cultured from the throat must be examined. This examination can be made only by infecting guinea pigs. The decision in both cases is very important. In the first case it is essential to know if the child is suffering with diphtheria so that the patient may be treated with serum as quickly as possible. In the second example, the control of epidemics in families, schools, military units, and so on depends on the result. Diphtheria serum, which is necessary for the treatment of the disease, can be prepared only by immunizing horses with diphtheria toxin. Our entire knowledge of diphtheria has its foundation in the careful experimentation upon guinea pigs and horses. The Schick test, discovered by the writer, was made possible only by studies upon guinea pigs.

We should not forget that the study of diphtheria contributes only one of the pillars upon which rest the development of the fundamental laws dealing with immunity against infectious diseases. The discovery of diphtheria serum by Behring gave an impetus to further studies for combating infectious diseases. Every mother should be thankful that science has developed a method of immunizing her child against such a terrible disease as diphtheria and should also be thankful for the discovery of a treatment for the disease.

As a pediatrician, I am able to judge the progress which has been made in the knowledge of diphtheria and other infectious diseases endangering the lives of children. Also as a pediatrician I

am able to judge the enormous progress made by studying rickets and the manifold forms of avitaminosis in animals. All these studies result in the saving of the health of millions of children and adults.

All such investigations are made in well controlled laboratories. Nobody should make use of animal experimentation without there being an absolute necessity for it. But if I must choose between helping science in finding new remedies for conservation of health in treating disease on the one side or sacrificing animals on the other I cannot hesitate to use animals.

MAJOR G. SEELIG, Professor of Clinical Surgery, Washington University School of Medicine, St. Louis, Missouri. In this age and day, there ought to be no finer demonstration of carrying coals to Newcastle than a formal defense of the humane use of warm blooded laboratory animals for purposes of developing scientific and practical medicine. I personally am never more reverent than when I contemplate the blessings that have graced man's life as a result of the studies that have been made on lower animals. When I ponder over the fact that we have made an almost complete scientific conquest of diphtheria and typhoid fever, gained an incredibly broad understanding of tuberculosis, and gathered an untold wealth of information regarding infections in general and when further I realize how many of the beneficences bound up with all this advanced thought have been won through the humane sacrifice of guinea pigs I feel no more revolt of conscience than I do regarding the fatal annual migrations of millions of those other little rodents, the lemmings when they voluntarily seek death in the sea. It was Disraeli who said that when he had to choose between monkeys or angels, he took his stand with the angels. In my turn I say that if I have to choose between guinea pigs, dogs, and you and my children I take the children as my preference.

There is no branch of the healing art that has not been strengthened as a result of properly conducted animal experimentation. It taxes patience to be reiterating this fact constantly. It is more important to realize the value of experiments on animals in attacking some of our up to now unsolved problems. Cancer is the greatest single killer among world diseases today, not even excepting primary heart disease. We do not know the cause of cancer we know all too little about its cure. As one who is devoting all his limited and humble capacity to the study of this world scourge, I say with conviction that were we to be

denied the right to use the lower animals in our studies, our progress toward conquering this disease would be hobbled even beyond the realm of wishful thinking.

MAURICE B. VIESCHER, Head of the Department of Physiology, University of Illinois College of Medicine, Chicago. The basis on which the scientist asks for approval of his use of animals for research and teaching is that of common sense reason. The medical scientist asks that two major questions be answered in the light of actual human experience. First, is there indubitable evidence that animal experimentation has been of value in medicine and the other biological sciences, and second, is man justified in the humane use of lower animal life for his own welfare? These questions, it seems to me, can both be answered vigorously in the affirmative. Especially since Pasteur, Koch, Lister, Curie, and Banting to enumerate but a few of the most prominent experimentalists, it is futile to deny that human happiness has increased due to specific discoveries based entirely on animal experimentation of various sorts. Regarding the ethical justification for employing animals for human ends, as long as our race uses meat, furs, leather and feathers, as long as we domesticate animals as beasts of burden on farm and highway, and confine them as pets for our amusement and company, it would seem that no great differences of opinion actually exist regarding our right to use animals for human good. A few fanatics abstain from meat, but they are usually the most inconsistent ones in regard to confining animals as pets and beasts of burden. Until animals are given every privilege and sanctity accorded man himself there can be no argument on the ethical side.

As a worker in the medical sciences it is perhaps appropriate for me to add one further statement. From a study of the history of medical progress I am convinced that every major advance in modern medicine has depended either immediately or remotely, but in the latter case none the less completely upon knowledge gained in animal experimentation. I stress the latter category because one frequently hears, even from within the medical profession, the statement that one or another great advance was made by study of the human directly. The last step is often, or one might say must always be made by observations on man, but the background of knowledge has invariably been gained by experiments on animals, experiments which usually are of such a character as to preclude their performance upon human subjects.

OWEN H. WAGENETHEIM, Professor of Surgery, University of Minnesota Medical School, Minneapolis. Lady Mary Wortley Montague who is frequently credited with having introduced inoculation against smallpox into western Europe, having observed the efficacy of vaccination in Turkey wrote her friend, Sarah Criswell in England in April, 1717: "I should not fail to write some of our doctors very particularly about it, if I knew any one of them that I thought had virtue enough to destroy such a considerable branch of their revenue for the good of mankind."

This implied objectivity of the medical profession has been adequately set aside by the unselfish toll of physicians in their daily tasks and the fervent zeal with which medical men have sought the cause and cure of disease. Epidemics of plague, cholera, and other infectious diseases of one sort or another that have ravaged and decimated the population of the earth for centuries have been obliterated by the labor of love of physicians who have devoted their energies and consecrated their lives to the task of making this a better and safer world wherein to live.

This record of accomplishment has been largely possible through the medium of animal experimentation. The fetters of authority and tradition have been broken. The deception of rationalization on inadequate factual data has become generally recognized and the superiority of experiment over logic has been demonstrated beyond question. The value of hypotheses resulting from carefully made observations is appreciated, but the verity of such deductions must be weighed by the crucial test of experiment. Art without science is blind.

Much of our knowledge of the mode of operation of our digestive, circulatory, respiratory systems, and ductless glands is the result of practical tests upon animals. Similarly the mode and means of the best therapeutic attack upon the diseases to which these viscera of man are heir has come about in large measure through animal experimentation. Those drugs which avail the most in the treatment of human ills have been discovered and their action and dosage determined through the agency of decisive trials upon animals. By the same means the pharmacopeia has been purged of reliance upon superstition and futile remedies in the treatment of disease.

Intelligent search for the cause and alleviation of disease must go on. One of the most valued instruments in this relentless inquiry is animal experimentation. Matters of such vital importance to health and happiness can not be left to chance. Biological research employing the sci-

tific method must continue its discoveries and benefits are available to all men irrespective of creed or birth or whether rich or poor through its agency more lives are saved than all the wars of all the ages have thrown away.

When man no longer slays animals for food or clothing or holds them subservient to his will, the significant value of truths learned in animal experiments will fully justify their performance for the protection and prolongation of human life.

METHODS OF MEDICAL PROGRESS¹

For a long time there has been need for a better understanding by the public of what constitutes animal experimentation. Unfortunately for a great many years, the only information given to the public concerning animal experimentation came from the opponents of progress in medical science, their utterances contained many misstatements and much misinformation. Those who were engaged in the study of disease were at first, too hasty to realize that progress in medicine was being endangered by professional agitators. They did not know that laudable work was being falsely portrayed to an always credulous public. We are always quite willing to believe much that we read and hear and it so happened that for a long time the public read and heard a great deal about the so called evils of animal experimentation. At the same time the public was not informed of the tremendous positive benefits of such work and thus made able to judge for themselves whether or not experimental research was justifiable.

The word vivisection which is often used to describe animal experimentation is an unfortunate one because it conveys a wrong picture to the mind of the average person. It does not begin to describe all that animal experimentation really is. It does not tell that the animals when used are rendered insensible to pain by an anæsthetic such as ether the same as with patients in a hospital. It does not tell that, in those instances in which the animal is allowed to come out of the anæsthetic, just as great care is taken to insure the aseptic and cleanly performance of the operation as in human surgery. It does not tell that the animals used suffer far less discomfort and make much more rapid recoveries than do human patients. It does not tell that the animals in the laboratories are usually under less discomfort than those which undergo cutting operations at the hands of farmers in the barnyards or are killed in the slaughtering pens. Yet all these things are so.

¹ A compilation of material assembled from various sources.

Just what constitutes animal experimentation? In the first place, more than half of it consists of nothing more painful than a needle prick for the purpose of injecting substances to determine their ability to produce disease and how they produce it. In either case a great many of the animals so used never have any ill effects following the injection nor do they succumb to the injection. In those that do succumb, death is no more painful than that due to natural causes. The other major phase of animal experimentation consists largely in the performance of operations much the same as those that human beings undergo daily in any hospital. These operations on animals have the added purpose of studying body functions, or of improving and perfecting methods that will save human lives later on. In these operations the animals used are under complete anæsthesia and the requirements relative to cleanliness and technique are just as strict as in human surgery.

Animal experimentation embraces many different lines of study. Animals are used for studying the physiology of the vital organs of the body, they are used for studying various contagious diseases such as diphtheria, scarlet fever, smallpox, and a host of others. Animals are used for working out the details and perfecting the methods of various operations that may be used to advance later on in human surgery. They are used for the determination of the suitable dosage of various curative drugs, finally animals are used to a great extent in producing vaccines and antitoxins for the prevention and cure of contagious diseases in man and the domestic animals. For example, calves are used in the commercial production of smallpox vaccine. One calf will produce sufficient vaccine to protect several hundred thousand people against smallpox.

What is the purpose of animal experimentation? Primarily its purpose is to find ways and means of conserving human life and the lives of domestic animals of diminishing the pain of natural disease and making death more comfortable. This is brought about by teaching us more about the organs of the body in health and in disease by studying the diseases of man and animals by means of reproducing them experimentally in animals and by discovering methods of improving health and of preventing and combating disease.

Who does animal experimentation? It is carried on in various laboratories throughout the world, most of which are connected with medical and veterinary schools or agricultural experiment stations. These laboratories are in charge of specially trained, responsible men who stand high

in their respective professions and in their communities. These men are pledged to see that the work in their laboratories is carried on in a proper humane, and careful manner. These men have dedicated their lives to the prolongation of human life and to the alleviation of suffering in man and beast. It should be noted that most investigators in research could obtain a greater financial return from work in less philanthropic fields, as the professions or business. It should be emphasized that the same major factors which have made modern surgery possible have also made modern animal experimentation possible. (1) discovery of anesthesia (2) discovery of bacterial origin of disease, (3) development of aseptic surgery.

The discoveries and applications in human medicine made possible by animal experimentation are innumerable. Only a very few can be mentioned as smallpox vaccination, diphtheria antitoxin, typhoid vaccination the recent discovery of insulin which has so much value in treating diabetes the recent discovery of the cause of scarlet fever and probable means for controlling it the discovery of ethylene as a general anesthetic and the recent discovery of treating pernicious anemia with liver. Added to these, there is the knowledge that has been obtained as to how the various body organs do their work and how they are affected in disease.

The saving of human lives by means of these discoveries is one of the brightest pages in medical history. Before the discovery of vaccination against smallpox, there occurred widespread epidemics of the disease which almost depopulated some communities. Today we rest in comparative security from the ravages of the disease because we have effective means of preventing it. Diphtheria used to be one of the most dreaded diseases and its toll of human life was large. Today, due to the discovery of diphtheria antitoxin, the death rate from that disease is negligible when the antitoxin is used promptly. In the Spanish-American war typhoid fever caused the death of six times as many men as all other causes put together. In the World War there was practically no typhoid fever for the very simple reason that a few years ago a vaccine was discovered which prevents the disease and today typhoid vaccination is a routine procedure in the armies not only of our own country but of other countries. In the United States army alone it is estimated that no less than 30,000 of our boys' lives were saved by typhoid inoculation. Thus one might go on and recount innumerable instances of how the lives, not of hundreds, but of millions of people have

been saved by discoveries that were made in laboratories using animals for observation.

Nor must we think that medical men have seen fit to use only the lower animals in their experiments. Time and again, doctors have volunteered as subjects in the study of certain diseases in which animals do not afford suitable media for the work. An instance is that of the American Commission appointed in 1900 to make an investigation of the deadly yellow fever in Cuba. It had existed perpetually in Havana, and occasionally it invaded this country especially the southern states where in one epidemic it caused the death of 15,000 persons. Yellow fever constituted one of the principal reasons for the French abandonment of the Panama Canal project. It had taken a toll of 2,000 workmen and no other than that pestilential zone was safe from it.

When the American Commission was appointed, no one had any clear proof either as to the cause of the disease or the means by which it was spread. As animals are not subject to yellow fever it was necessary for men to volunteer. To make a long story short, it was found that yellow fever was spread by a certain variety of mosquito. A method of combating it was developed, but in so doing some of the doctors and private soldiers of the army who had volunteered as subjects gave their lives. They rendered an overwhelming service to humanity then the army by whom the mosquitoes wiped out yellow fever in Havana forever.

Later, this discovery made possible completion of the Panama Canal by our own country only after the Canal Zone was free of yellow fever was concerned. It should be noted that the discovery of the cause of the disease made it necessary for the experimental investigation of the disease thus their training in the investigation and the comparable disease in the

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